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Soil Survey

Grainger County Tennessee

By
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Tennessee Agricultural Experiment Station

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils, and Agricultural Engineering
In cooperation with the
TENNESSEE AGRICULTURAL EXPERIMENT STATION
and the
TENNESSEE VALLEY AUTHORITY

HOW TO USE THE SOIL SURVEY REPORT

SOIL SURVEYS PROVIDE a foundation for all land use programs. This report and the accompanying map present information both general and specific about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or only in some particular part. Ordinarily he will be able to obtain the information he needs without reading the whole. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers of three general groups: (1) Those interested in the area as a whole; (2) those interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. Attempt has been made to meet the needs of all three groups by making the report comprehensive for purposes of reference.

Readers interested in the area as a whole include those concerned with general land use planning—the placement and development of highways, power lines, urban sites, industries, community cooperatives, resettlement projects, and areas for forest and wildlife management and for recreation. The following sections are intended for such users: (1) General Nature of the Area, in which location and extent, physiography, relief, and drainage, climate, water supply, vegetation, organization and population, industries, transportation and markets, and cultural development and improvement are discussed; (2) Agriculture, in which a brief history and the present status of the agriculture are described; (3) Productivity Ratings and Physical Land Classification in which are presented the productivity of the soils and a grouping according to their relative physical suitability for agriculture; (4) Land Use and Soil Management, in which the present uses of the soils are described, their management requirements discussed, and suggestions made for improvement; and (5) Water Control on the Land, in which problems pertaining to drainage and control of runoff are treated.

Readers interested chiefly in specific areas—as some particular locality, farm, or field—include farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real estate agents, land appraisers, prospective purchasers and tenants, and farm loan agencies. These readers should (1) locate on the map the tract with which concerned; (2) identify the soils on the tract by locating in the legend on the margin of the map the symbols and colors that represent them; and (3) locate in the table of contents in the section on Soils of the County the page where each type is described in detail and information given as to its suitability for use and its relations to crops and agriculture. They will also find useful specific information relating to the soils in the sections on Productivity Ratings, Physical Land Classification, Land Use and Soil Management, and Water Control on the Land.

Students and teachers of soil science and allied subjects—including crop production, forestry, animal husbandry, economics, rural sociology, geography, and geology—will find their special interest in the section on Morphology and Genesis of Soils. They will also find useful information in the section on Soils of the County, in which are presented the general scheme of classification of the soils of the area and a detailed discussion of each type. For those not already familiar with the classification and mapping of soils, these subjects are discussed under Soil Survey Methods and Definitions. Teachers of other subjects will find the sections on General Nature of the Area, Agriculture, Productivity Ratings, Physical Land Classification, and the first part of the section on Soils of the County of particular value in determining the relation between their special subjects and the soils of the area.

This publication on the soil survey of Grainger County, Tenn., is a cooperative contribution from the—

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SOIL SURVEY OF GRAINGER COUNTY, TENNESSEE

By E. H. HUBBARD, in Charge, B. L. MATZEK, and CLIFTON JENKINS
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United States Department of Agriculture in cooperation with the Tennessee Agricultural Experiment Station and the Tennessee Valley Authority

CONTENTS

THE physiography and soil characteristics of Grainger County vary greatly, and agriculture also is widely diversified. Corn, wheat, lespedeza, clover, alfalfa, other hay crops, tobacco, and vegetables are the principal crops grown, most of them for local consumption. The horses, mules, cows, and hogs raised are chiefly for farm use or local markets. Poultry furnishes about 20 percent of the total farm income as well as food for the home. The county has no important industries. To provide a basis for the best agricultural uses of the land a cooperative soil survey was begun in 1940 by the United States Department of Agriculture, the Tennessee Agricultural Experiment Station, and the Tennessee Valley Authority. The essential findings in this survey may be summarized as follows.

SUMMARY

Grainger County is situated in the northeastern part of Tennessee. The relief is dominated by Clinch Mountain, which rises to an altitude of 2,200 to 2,500 feet. In general the elevation ranges from 850 to slightly more than 2,500 feet. The county is drained by the Clinch and Holston Rivers.

The soils of the county differ widely in the characteristics and conditions that influence productivity and use capability. Some of these are texture, consistence, fertility, reaction, color, slope or lay of the land, content of organic matter, and conditions of erosion, stoniness, and moisture. Largely upon the basis of such differences the soils have been classified and mapped into 128 units, including soil types, phases, and miscellaneous land types.

Of the total county area, less than 1 percent requires artificial drainage for tillage. About 28 percent of the county has a nearly level to rolling relief, 38 percent is hilly, and 34 percent has a steep relief. About 29 percent has suffered moderate erosion, 12 percent severe erosion, and 3.5 percent has been reduced to a severe gullied condition. Taking the average of the Great Valley of East Tennessee as a standard, about 6.5 percent of the land considered suitable for growing crops is relatively high in natural fertility and productivity, about 35.5 percent is medium, and 58 percent is relatively low. Virtually all soils of the uplands are acid. Tilth conditions are generally good except on some of the silty clay loams.

For physical land classification purposes the soils are grouped into five classes on the basis of physical suitability for broad farm uses. In general, First-, Second-, and Third-class soils are physically adapted for crops requiring tillage; Fourth-class soils are not considered physically suitable for crops but are well to very well suited to pasture; and Fifth-class soils are considered physically unsuitable for either crops or pasture but are suitable for forestry.

In Land Use and Soil Management the soils of four physical land classes are placed in 13 groups on the basis of management requirements. Each group is discussed with respect to choice and rotation of crops; use of lime, commercial fertilizers, and manure; tillage practices; engineering methods for the control of water on the land; practices of good pasture management. As the soils of the fifth physical land class are so poorly suited either to crops or to pasture, management requirements are not given for them; these soils are used largely for forest, and forest management is discussed in the section on Forests. The relation between the production of forest and the soils and the place of forestry in the agriculture of the county are also described.

Morphology and Genesis of Soils is treated in relation to the factors of soil formation and the conditions of these factors in the county. The soils are grouped into higher categories; soil series are described; and the factors of soil formation that have influenced its morphology are discussed. The great soil groups represented are the Red and Yellow Podzolic soils.

GENERAL NATURE OF THE AREA

Grainger County is characterized by a strongly rolling to steeply sloping surface about 40 percent of which is forested. A few prominent steep ridges, chief of which are Clinch Mountain and Poor Valley Ridge, are almost completely forested and are very poorly suited to agriculture. The remaining part has an intricate pattern of soils of a wide range of suitability for agricultural use.

Practically all the land suited to tillage or pasture is used for these purposes. Very little is in specialized crops. Corn, hay, and wheat are the principal crops. Some tobacco is raised as a cash crop, and there are no industries. Cherokee and Norris Reservoirs and Clinch Mountain are natural recreational resources.

LOCATION AND EXTENT

Grainger County, in the northeastern part of Tennessee, is separated from the Virginia-Kentucky State line by one tier of counties (fig. 1).

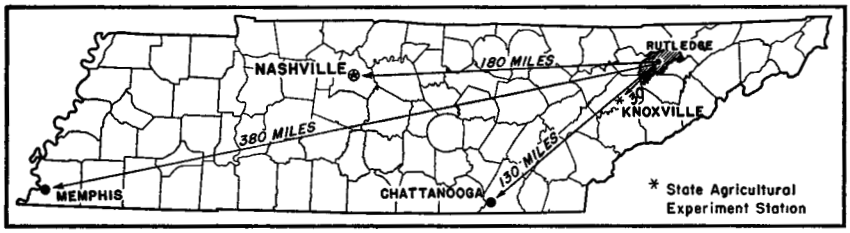

FIGURE 1.—Location of Grainger County in Tennessee.

The county, about 28 miles long and 11 miles wide, is roughly rectangular in outline and extends in a northeast-southwest direction. Rutledge, the county seat, is 30 miles northeast of Knoxville and 180 miles east of Nashville. The northern boundary is formed by the Clinch River and the southern and southeastern by the Holston River. The total land area is 279 square miles, or 178,560 acres.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

Physiographically, the county is situated within the Valley and Ridge province which is commonly known as the Great Valley of East Tennessee. Although this valley is a belt of lowland in relation to the enclosing parallel highland belts, it varies from place to place in both relief and elevation.

For the most part the Great Valley of East Tennessee is underlain by limestone and associated beds of shale that have been folded and faulted. Geologically this material has been weathered and eroded more rapidly than either the rocks of the Great Smoky Mountains on the east or the Cumberland Mountains on the west.

In Grainger County the underlying rock consists of limestone, shale, and sandstone. The limestone and shale show wide variations in content of carbonates. Most of the shale is noncalcareous, but some of it has thin interbeds of limestone. Because of the folding and faulting, the pattern of the exposed geologic material is relatively intricate.

Although all the rocks of the area weather faster than those of the enclosing highlands, their rates of weathering are not all the same.

Cherokee Dam on the Holston River looking upstream from Quarry Hill. The relatively narrow
chiefly of Cumberland soils on the bench and Bruno fine sandy loam adjacent to the stream
left half. Hills of Jefferson and Hamblen Counties in the distance.

Cherokee Dam on the Holston River built by the Tennessee Valley Authority as a part of the progra
This structure impounds a body of water covering about 31,000 acres, about half of which lies
recreational facilities for the county and the surrounding region. Managing surrounding lands
the resultant silting up of the reservoir is important not only locally but also to more distant co
Hills of Jefferson County in the background.

Severe folding and faulting of the rocks and differential weathering incident to variations in character of the underlying rocks have resulted in a series of many parallel physiographic belts crossing the county in a northeast-southwest direction. These belts, from northwest to southeast, are (1) Hinds Ridge in the northwestern part of the county; (2) Log Mountain and War Ridge southeast of and parallel to Hinds and Chestnut Ridges (the latter in Claiborne County); (3) Copper Ridge; (4) Clinch Valley (pl. 3, *A*); (5) Clinch Mountain; (6) Poor Valley; (7) Poor Valley Ridge; (8) Richland Valley; (9) Richland Knobs, and (10) the Skinfoot Ridge in the southeastern part.

Hinds Ridge is underlain by Knox dolomite (*13*)[1], and the soils are predominantly of the Fullerton and Clarksville series. The northeastern half is dissected by the Clinch River, and in all places it is completely dissected by small drains. The main ridge crest is not so broad as that of some of the other dolomitic limestone areas, and the prevailing topography is hilly and steep. The elevation of the higher points is more than 1,500 feet, which is 300 to 400 feet above the adjoining valley floors[2]. The total area is about 20 square miles.

The southeastern slopes of Log Mountain and War Ridge are underlain by somewhat purple acid shale of the Rome formation, on which Lehew soils predominate, and the northwestern slopes by interbedded limestone and shale of the Nolichucky formation, on which Hilly stony land (Talbott soil material) predominates. The ridge crest is narrow and the slopes on both sides are steep. The Clinch River cuts through these mountains near its junction with Indian Creek, and there are gorges of smaller streams through it in several other places. In most places the elevation of the crest of the mountain is 400 to 500 feet above the adjoining valley floors (*13*). The total area is about 15 square miles.

Copper Ridge is underlain chiefly by Knox dolomite, although the northwestern edge is underlain by a belt of Nolichucky shale. Fullerton and Clarksville soils predominate. The ridge crest is narrow, as it is rather completely dissected by small drains. It is cut through in several places by small creeks flowing towards the Clinch River. In general the topography is rolling to steep. The elevation of the ridge crest ranges from 300 to 400 feet above the adjoining valley floor. About 30 square miles are included in this division.

Clinch Valley is underlain by Holston marble and Chickamauga and Moccasin limestones. Stony land types and soils of the Talbott, Dewey, and Sequoia series predominate. Outcrops of bedrock are numerous. In most places the elevation is 1,100 to 1,200 feet. Some stream dissection has taken place and limestone sinks are numerous. The relief is dominantly rolling to hilly. This division embraces about 20 square miles.

Clinch Mountain, the most prominent physiographic division in Grainger County, rises to an elevation of 1,000 to 1,600 feet above the adjoining valleys. The southeastern side is underlain by Clinch and Clinton sandstones, on which Muskingum soils predominate, and the northwestern side is underlain by Bays Sandstone and Sevier shale, on which Armuchee and Hayter soils predominate. This mountain marks the drainage divide between the Clinch River on the north and the

[1] Italic numbers in parentheses refer to Literature Cited, p. —.
[2] Elevation data from U. S. Geological Survey topographic maps.

Holston River on the south. The terrain is that of a narrow mountainous ridge, and the sharp configuration has been intensified by drainage channels cut down the slopes. The total area is about 35 square miles.

The very narrow Poor Valley is underlain in most places by Chattanooga shale, covered in most places by a layer of colluvial material from the surrounding mountains and hills. Jefferson and the less steep stony phases of the Muskingum soils predominate. The relief is gently rolling. The total area is about 3 square miles.

Poor Valley Ridge is underlain largely by Grainger and Rome shales, and Muskingum soils predominate. These knobs, generally 400 to 500 feet above the adjacent valley floors, are rather completely dissected by streams, and small creeks draining the southeastern side of Clinch Mountain and Poor Valley cut through them in many places. The relief is dominantly steep. The total area is about 25 square miles.

Richland Valley is underlain by Rutledge and Maryville limestones (*13*), separated from each other by a narrow strip of Rogersville shale. Decatur, Dewey, Sequoia, and Hayter soils predominate on Rutledge limestone, stony land types on Maryville limestone, and Montevallo soils on the Rogersville shale. The mean elevation of this valley is about 1,000 feet. Limestone outcrops are numerous on the southeastern side. Some stream dissection has taken place, and limestone sinks are numerous. The relief is undulating to strongly rolling. This division covers about 35 square miles.

Richland Knobs are underlain by Nolichucky shale. This formation is composed of interbedded shale and limestone and Armuchee soils, and stony land types predominate on it. Embracing an area of about 15 square miles and rising about 400 feet above adjoining Richland Valley, these knobs are dissected by small drains, and the topography is generally steep.

The Skinfoot Ridge is underlain largely by sandy dolomite of the Knox dolomite formation, on which sandy Fullerton and Clarksville soils predominate. The elevation ranges from 900 to 1,400 feet. Considerable stream dissection has taken place, and limestone sinks are numerous. The prevailing relief is rolling to hilly. This ridge covers an area of about 81 square miles.

Those parts of the county underlain by limestone are characterized by so-called limestone sinks resulting from underground solution of the rock. They are usually small and shallow with steep, sharp slopes.

In addition to these 10 physiographic divisions, there is a small area and a narrow broken belt underlain by Nolichucky shale and Maryville and Rutledge limestones along the southeastern border of the Skinfoot Ridge of the sandy dolomite area. This division roughly parallels the Holston River from Cherokee Dam (pls. 1 and 2) northeast to the Hawkins County line, and much of the stream terraces and bottom lands are on it. Part of its 10 square miles has been submerged by the Cherokee Reservoir. Slopes underlain by Nolichucky shale are steep, and by Maryville and Rutledge limestones, undulating to strongly rolling.

There is also a small hilly to steep area of Armuchee soils over Newman limestone adjacent to the Hawkins County line and northeast of Tate Springs. This shaly limestone is the youngest consolidated geologic formation in the county.

Very few terraces and little stream bottom lands have developed along the Clinch River in Grainger County, and though they are wider along the Holston River, they are relatively narrow, seldom more than a fourth of a mile wide. These first- and second-bottom areas along these two rivers occupy about 12 square miles, part of which has been submerged by the Cherokee and Norris Reservoirs. The Clinch River has cut a winding channel 300 to 400 feet below the uplands, and the enclosing slopes to the river are rather steep and are incised by tributary streams; the Holston River has cut a meandering channel, in most places less than 200 feet below the uplands.

The present relief is the result of the forces of weathering on the sedimentary rocks during a long geologic period. On the so-called insoluble rocks—sandstone and shale—the weathering has been chiefly geologic erosion by running water; but on the relatively soluble limestone, weathering has been by dissolution by percolating waters. The geologic formations that consist of the rocks most resistant to weathering have given rise to ridges, and the formations consisting of rocks less resistant to weathering have become the valleys. The ridges and valleys follow the outcrops of the slowly and the rapidly weathering rocks, respectively, the directions of which are parallel to the strike of the rocks.

The highest points in the county, slightly exceeding 2,500 feet, are on the crest of Clinch Mountain; the lowest, 850 feet, is where the Holston River leaves the county. Most of the valley floors lie 1,000 to 1,400 feet above sea level, and most of the ridge tops attain altitudes of 1,500 to 1,600 feet.

The approximate altitudes of the following points afford a key to the relief of Grainger County: Clinch River at Union County line before establishment of Norris Reservoir, 950 feet; Clinch River at Hancock County line, 1,080; Holston River at Knox County line, 850, and at Hawkins County line before the establishment of the Cherokee Reservoir, 980; Norris Reservoir, 1,020; Cherokee Reservoir, 1,075; Elm Springs School, on Hinds Ridge, 1,420; crest of Copper Ridge, 1,600 to 1,700; crest of Log Mountain, 1,650 to 1,750; crest of Clinch Mountain, 2,200 to 2.500; Skinfoot Ridge, 1,200 to 1,500; Poor Valley Ridge, 1,400 to 1,700; Richland Knobs. 1,500 to 1,700; Rutledge, in Richland Valley, 1,015; Washburn, in Clinch Valley, 1,404; and Poor Valley, 1,000 to 1,200 feet.

Drainage is well developed, and the two rivers flow in the general direction of the slope, which is southwest. Clinch Mountain divides the drainage between the Clinch River to the northwest and the Holston River to the southeast. The southeastern third of the county has developed a fairly well-defined dendritic drainage pattern, and the rest has developed a fairly well-defined trellis pattern. In the areas underlain by limestone some of the drainage water enters underground channels through sinkholes. Because of these numerous sinks and underground streams the local surface drainage pattern in some places is disconnected and irregular.

In general, water is plentiful in all parts of the county. Springs are numerous, particularly in areas underlain by limestone. Streams, springs, and ponds provide water for livestock. Water for human consumption is supplied by springs, wells, and cisterns. Considerable

fishing, for sport and recreation, is done in the streams and rivers. In addition to Cherokee and Norris Reservoirs there are a few small artificial lakes but no natural lakes.

CLIMATE

The climate of Grainger County is temperate and continental. Its salient features consist of moderate winters characterized by short erratic cold spells, mild summers with cool pleasant evenings, and a well-distributed mean annual precipitation of 44.54 inches, including 10.3 inches of snow. Summer temperatures of more than 95° F. are uncommon. The difference between mean summer and winter temperatures is not great, being only about 35°.

The average frost-free season is 188 days, extending from April 16, the average date of the last killing frost, to October 21, the average date of the first. This provides ample time in which to grow and mature all the crops generally grown. Frosts have occurred as late as May 10 and as early as September 26. Frosts late in spring sometimes cause injury to some crops, particularly fruit. The grazing season extends from about the middle of April to the middle of November.

Winters are for the most part sufficiently mild and open to allow outdoor farm work throughout the season. Although there normally is some snowfall in winter, the snow generally melts in a few days. On well-drained soils there is very little winter-killing of such crops as alfalfa, red and crimson clovers, and winter wheat, oats, barley, and rye. The winters are usually mild enough to permit the growth of certain vegetables.

Rainfall is well distributed throughout the year, about 82 percent of it being nearly equally divided between winter, spring, and summer. The lightest precipitation is in fall, when the crops are maturing and being harvested. Precipitation generally is ample for most crops, although sufficient moisture for optimum growth commonly is lacking in late summer and early fall. Occasionally excessive precipitation damages crops, especially on bottom lands subject to flooding. Much of the precipitation, particularly in summer, comes in rather heavy showers, but most of it, especially in winter, comes in slow, gentle rains that last for half a day or more.

Although no data of purely local variations in temperature and precipitation are available, it is apparent that the variations do exist. So far as known, such variations are explained by lay of the land, including direction of slope, the effect of relief on air drainage, differences in elevation, and proximity and relation to mountains. Frosts frequently occur in valleys and depressions when vegetation on the ridges shows no frost effects, and the early fall and late spring frosts are invariably more injurious in the lower situations. Frost injury of fruit trees is less frequent on ridge tops and north-facing slopes, because spring growth is retarded here as compared with orchards on south-facing slopes. Winter-killing of perennials, small grain, and other winter crops, due to freezing and heaving, is more frequent on slopes characterized by seepage. That part of Clinch Mountain within the county reaches an elevation of about 2,500 feet, and here the mean temperature is lower; showers are more frequent, and total precipitation of both rain and snow is greater. Wind velocity is relatively low and the

humidity moderate. Destruction or damage by hailstorms and tornadoes is to be expected, but not often.

Table 1 compiled from the records of the United States Weather Bureau station at Rogersville, in Hawkins County, about 30 miles northeast of Rutledge, gives the normal monthly, seasonal, and annual temperature and precipitation at that place, which is representative of Grainger County.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Rogersville, Hawkins County, Tenn.*[1]

(Elevation, 1,096 feet)

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year	Average snowfall
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	39 0	71	−18	4 22	2 21	10 70	2 6
January	37 9	74	−13	3 86	1.96	3.86	3 4
February	40 1	79	−17	3 71	.81	1 41	2.3
Winter	39 0	79	−18	11.79	4 98	15 97	8 3
March	48 0	86	7	4 58	3 66	4.66	1.1
April	56 6	95	20	3.57	3 14	4 99	.5
May	65.0	95	30	3 74	1.83	4 95	(2)
Spring	56 5	95	7	11.89	8 63	14 60	1.6
June	72 6	98	40	4 17	3.44	2.96	0
July	75 5	101	48	4 65	5 68	2 72	0
August	74.7	102	48	3 99	1.66	10.21	0
Summer	74 3	102	40	12.81	10 78	15.89	0
September	69 9	103	32	2 83	1 57	4.60	0
October	58 1	91	19	2 63	2 14	1 48	(2)
November	46.7	80	6	2.59	2 18	1.30	.4
Fall	58 2	103	6	8 05	5 89	7.38	.4
Year	57.0	[3]103	[4]−18	44 54	[5]30 28	[6]53 84	10.3

[1] Data from U. S. Weather Bureau.
[2] Trace.
[3] In 1925.
[4] In 1917.
[5] In 1941.
[6] In 1901.

WATER SUPPLY

Water for livestock and household use is available in most parts of the county either from springs, shallow wells, or streams. It is not so plentiful on the steep ridges, such as Clinch Mountain and Poor Valley Ridge, but these areas are poorly suited to agriculture and their water requirements are not large. In some areas on the cherty ridges where water is not easily available, cisterns for household use and artificial ponds for livestock are common. Some of the smaller streams or springs generally cease to flow during the more protracted dry periods. Cherokee and Norris Reservoirs are large permanent bodies of water that afford considerable watering facilities for livestock along their extensive shore lines.[3]

VEGETATION

Before white men came to this region, the entire county was chiefly in deciduous forest. The oak was probably the dominant tree, but

[3] Livestock have access to this water either through rental of adjacent land or by water-lane permits granted by the Tennessee Valley Authority.

there were also many chestnuts and pines. Other less common species were yellow-poplar (tuliptree), elm, maple, gum, hickory, black walnut, and dogwood. About 1920 all the chestnut was killed by blight. Practically all the forest has been removed or cut-over. About 40 percent of the area is now occupied by cut-over forest that supports a few small sawmills.

ORGANIZATION AND POPULATION

Grainger County, the thirteenth county in the State to be formed (*1*), was created by an act of the legislature on April 22, 1796, from parts of Knox and Hawkins Counties (*3*), 9 days previous to the date the State was admitted into the Union (*8*). At that time Grainger County included a considerable part of Claiborne, Campbell, Union, and Hamblen Counties (*4*).

The settlement of what is now Grainger County began about 1785, along the valley southeast of Clinch Mountain (*4, 6*). The first white settlement was made at Bean Station about that time, and for more than half a century previous to the building of the railroads it was one of the most widely known places in Tennessee. It was named in honor of the Bean brothers, who erected a fort there in 1787 to protect settlers from the Indians. Rutledge, the county seat, was established in 1798. The first church was established at the mouth of Richland Creek in 1798 (*4*). Most of the early settlers came from the bordering counties and States to the northeast (*6, 4*), chiefly Virginia and North Carolina. The population reached a high of 17,824 in 1850 (*6*), but the county then included a much larger area than at present. According to the 1940 census the population is 14,356, all classed as rural. There are only 255 Negroes, and none of the population is foreign-born. The majority of the white population is of English, Scotch, and Irish descent.

INDUSTRIES

Agriculture is the only industry of great importance in the county. It is estimated that the total personnel employed by other industries would not exceed 100. In Rutledge is a hosiery mill and a marble quarry. A resort at Tate Springs employs about 25 people during the summer season. A rather large marble quarry is near the junction of Indian Creek with Norris Reservoir. Some part-time employment is furnished by the forest industry.

TRANSPORTATION AND MARKETS

In the early days transportation facilities were afforded by the Holston and Clinch Rivers, wagon roads, and other crude methods of travel overland to Baltimore, Philadelphia, Richmond, Charleston, and Louisville. The small supplies purchased came largely from the first two cities. Most of the farm products were floated down the rivers in flatboats to New Orleans and other trading centers along the stream. Most of the horses, cattle, mules, hogs, sheep, and turkeys were driven over the mountains to Charleston. Several hundred thousand mules, horses, cattle, and hogs from Kentucky, destined to the Carolinas passed over the Louisville-Charleston road annually (*6*). The extension of rail facilities through Morristown and Jefferson City in the adjoining counties in 1858 and through Washburn and the northwestern part of

Grainger County improved marketing facilities considerably, as did also the later construction of the Federal and State highways and the improvement of highways in general throughout the county.

A branch line of the Southern Railway, between Knoxville, Tenn., and Middlesboro, Ky., serves the northwestern parts, but about four-fifths of the county gets its chief rail transportation facilities through Morristown and Jefferson City, both of which are outside. A branch line from Knoxville through Bean Station to Morristown was completed in 1891 but was abandoned in 1929.

The county is well supplied with Federal and State highways. United States Highway No. 11 W, the main road between Knoxville and Kingsport, crosses the county from southwest to northeast. Other important roads are United States Highway No. 25 E and State Highways Nos. 92 and 61. Communities not on these highways are served by county and community roads, most of which are graveled and maintained in fairly good condition most of the year. All communities are served by roads that are in a passable condition throughout the year.

Farm products are sold locally or to outside markets. Most of the corn, vegetables, and dairy products are consumed locally, as also is much of the wheat, but some is marketed in Knoxville. Tobacco is marketed in Knoxville, Tazewell, Rogersville, and Morristown. Tomatoes are canned and shipped to various places. Beef and dairy cattle, swine, sheep, and lambs are marketed in Knoxville and Morristown. Some poultry and poultry products are marketed cooperatively through Morristown to the eastern markets.

CULTURAL DEVELOPMENT AND IMPROVEMENT

All parts of Grainger County are provided with grade schools, many of which are consolidated. High school facilities are provided at Rutledge and Washburn. Churches are conveniently located.

Telephone service is available in some of the larger communities and along the lines connecting these places. In 1940, 75 farms had telephones. Electricity is available in most of Richland Valley and along United States Highway No. 25 E between Bean Station and Morristown. A few homes and small villages have their own 32-volt systems.

In general farmhouses are modest. Most of them are constructed of lumber, and a few are equipped with modern conveniences, as electric lights and running water. Many are in need of repairs and paint. Barns and sheds are constructed of lumber; most of them are unpainted, and many are in need of repairs.

AGRICULTURE

HISTORY AND DEVELOPMENT

Before the coming of the white man, the Cherokee Indians practiced a crude form of agriculture, growing corn, beans, and pumpkins (*8*). Early records indicate an abundance of wild fruits—grapes, persimmons, blackberries, strawberries, mulberries, plums, apples, peaches, pawpaws, hickory nuts, and walnuts. (*8, 6*).

Although authentic information is meager, it is apparent that the white man's first agriculture in this area typified American pioneer life, in that it consisted primarily of growing subsistence crops, chiefly corn

(*8*). This crop is one well adapted to virgin conditions, easy to grow, not exacting as to time of harvest, has a wide range in adaptability to different soils, and provides a staple food for both man and beast. Flax, wheat, oats, rye, barley, horses, cattle, sheep, hogs, and poultry were raised for local needs. Sugar was made from sap of the maple, and clothing, shoes, and furniture were made at home (*6*). Corn bread, potatoes, garden vegetables, milk and milk products, salt pork, chickens, eggs, and wild game constituted the principal foods. Agriculture was, as it has been since, the main industry, and almost every man had a farm or a garden.

CROPS AND PRACTICES

Tables 2 and 3 present data on the acreage and the value of the farm products in certain years.

TABLE 2.—*Acreage of the principal crops and number of fruit trees in Grainger County, Tenn., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn for grain	25,832	26,859	30,188	27,832	26,514	18,936	20,526
Wheat	12,895	9,698	16,546	7,412	8,453	4,878	4,689
Oats	10,568	10,779	3,104	4,667	2,529	284	357
Barley	5	----	5	4	46	----	735
Rye	167	25	44	48	118	123	164
Hay and forage, total	1,527	4,038	4,537	9,277	23,062	10,499	13,254
Clover or timothy, alone or mixed	----	----	----	4,821	3,703	4,364	3,145
Clover alone	----	----	664	----	1,021	323	35
Alfalfa	----	----	----	----	64	131	726
Lespedeza	----	----	----	----	----	----	6,581
Annual legumes for hay	----	----	----	----	1,768	1,429	557
Small grain hay	----	----	943	1,385	291	119	455
Other tame hay	----	----	2,825	2,575	2,041	2,289	1,125
Wild grasses	----	----	29	59	365	103	204
Silage and coarse forage	----	----	76	437	13,809	1,741	426
Potatoes	----	269	305	466	322	383	509
Sweetpotatoes	335	197	261	223	179	172	212
Other vegetables for sale	----	----	----	----	564	413	285
Tobacco	48	29	46	20	44	1,278	2,284
Sweet sorghums for sirup	----	411	152	233	310	50	62
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Apple trees	----	43,226	73,828	74,787	52,836	43,568	30,169
Peach trees	----	52,384	9,198	35,303	36,260	21,004	22,889

TABLE 3.—*Value of agricultural products, by classes, in Grainger County, Tenn., in stated years*

Product	1909	1919	1929	1939
Cereals	$ 439,155	$1,159,363	$ 449,710	$ 414,592
Other grains and seeds	3,698	7,044	1,697	14,998
Hay and forage	103,221	546,791	169,615	199,629
Tobacco	------	------	324,215	361,393
Vegetables (excluding potatoes and sweetpotatoes)	103,810	221,515	161,951	144,486
For sale[1]	------	------	20,873	11,563
Farm household's use[1]	------	------	85,863	94,150
Potatoes and sweetpotatoes	------	------	55,215	38,773
Fruits and nuts	68,553	49,919	39,107	29,005
All other crops	151,183	15,826	2,784	2,255
Livestock products:				
Dairy products sold	14,680	43,784	60,697	64,061
Poultry raised and eggs produced	181,919	267,401	305,491	149,459
Wool	3,174	4,622	3,100	730
Honey and wax	3,859	7,711	2,476	2,677
Cattle, swine, and sheep sold or slaughtered	438,710	------	------	307,100
Forest products sold	------	------	48,297	23,772

[1]Excluding potatoes and sweetpotatoes.

The more significant changes in the acreage of the principal crops as shown in table 2 are as follows: A consistent increase of hay and forage crops, including lespedeza and alfalfa; a large increase in tobacco in the decade between 1919 and 1929; an increase in barley; a decline in oats and to a lesser degree in wheat; a general decline of the acreage of corn from the high point of 1899; while the acreage in rye and vegetables, including potatoes, has changed but little. The lespedeza crop has developed almost entirely during the last two or three decades.

Corn has been, and still is, the most extensive crop. In 1939 the total acreage was more than three times as great as the combined acreages of wheat, oats, rye, and barley; and about one and a half times as large as the total acreage of all hay and forage crops. Even though the total corn acreage is still large, it declined from a high of 30,188 in 1899 to 20,526 in 1939. Corn is grown in all parts of the county where agriculture is practiced and constitutes the principal crop on many farms. It has a wide range in adaptability to soil conditions, and, in this county, advantage is taken of this characteristic, as it is grown on a wide variety of soils, but the yields obtained differ greatly, depending primarily upon the type of soil, the kind of soil management, and the variety grown. Much of the corn is consumed on the farm, where it is used both as livestock feed and for household needs. That used for food is generally ground into meal at local mills. The rest is sold, generally at the local markets.

Wheat acreage has decreased from a high of 16,546 in 1899 to a low of 4,689 in 1939. The greater part of this crop is grown on the fine sandy loam types of the Fullerton and Clarksville soils, which dominate the Skinfoot Ridge or cherty hill parts of the county. Much of the wheat is ground into flour at local mills and consumed in the farm homes; some is fed to poultry, and some is sold to nearby markets.

Fifty years ago, oats was a relatively important crop, but at present it is insignificant. The total acreage declined from 10,568 in 1879 to 357 in 1939. The acreage in rye has never been very large. From the low of 25 in 1889, it rose gradually to 164 acres in 1939. The total barley acreage has been low, except in 1939, when it rose to 735 acres.

Land in tobacco did not exceed 50 acres in any census year from 1879 to 1919, but in the decade between 1919 and 1929 the acreage rose abruptly to 1,278, and in 1939 to 2,284. This strictly cash crop is generally grown on the best soil available on the farm. Most of it is sold in Knoxville, Morristown, Rogersville, and Tazewell.

The total acreages in potatoes and sweetpotatoes have maintained a more or less uniform level since 1879, and in 1939, 509 acres were in potatoes and 212 in sweetpotatoes. These crops are generally grown in small patches and consumed locally. Most farms have a small garden in which vegetables are grown, mainly for home use but some for sale. The vegetables commonly grown are peas, beans, onions, tomatoes, turnips, beets, cabbage, lettuce, spinach, carrots, and watermelons.

Many farms have small orchards of apples and peaches for home use, but few orchards are given any special care and the quality of the fruit is not high. The number of apple trees decreased from 43,226 in 1889 to 30,169 in 1939; and of peach trees from 52,384 to 22,889. Blackberries, dewberries, and huckleberries grow wild and are to some extent

picked for home consumption. Some strawberries, cherries, grapes, pears, and plums are grown.

Hay and forage crops are very important in the agriculture of the county. Although the total acreage dropped from a peak of 23,062 in 1919 to 10,499 in 1929, the drop was mostly in silage and coarse forage, whereas the acreage of legumes actually increased. The acreage in lespedeza has increased greatly in the last 20 years and it is now grown on practically all well-drained soils and is one of the most important hay crops of the county. Clover or timothy, alone or mixed, are important hay crops. Alfalfa is gaining in importance, but the total acreage in 1939 was only 726. Soybeans and cowpeas are grown for hay on many farms. Recent increased use of lime and phosphate has encouraged the growth of more legumes and grasses for hay and forage crops.

Pastures are also important in the agriculture of the county. The census for 1939 reports 42,487 acres of plowable pasture. Bluegrass and white clover are the predominant pasture plants on the most fertile soils. In other pastures there is usually a mixture of ryegrass, orchard grass, redtop, lespedeza, white clover, and bluegrass. The quality of the grass differs greatly from place to place.

Tillage practices are similar to those throughout the northern part of the Great Valley of East Tennessee. Many farms lack labor-saving machinery, and much work is done by hand or with one-horse implements. Some of the steep hillsides tilled can be worked only with hand tools and light implements.

Most farmers use a turning plow as the initial step in preparing the seedbed for intertilled crops and alfalfa; this is usually followed by a spike, or drag, harrow. Corn is usually planted with a one-row planter or by hand; tobacco and potatoes also are planted by hand. These crops are usually cultivated with a one-horse cultivator or a double shovel, and many farmers use a hoe to kill the weeds not thus reached.

Generally, intertilled crops are followed by close-growing fall-sown crops, which are drilled directly without seedbed preparation though in some instances the land is first disked. Usually hay crops are sown in growing grain in spring.

Most of the corn is cut by hand and shocked, though some, particularly on the bottom lands, is snapped off and only a very small percentage is topped. Most of the small grain is cut with a binder, but the use of combines for cutting and threshing is increasing. The old-fashioned cradle is still used by a few farmers. Nearly all the hay is cut with a mowing machine, raked with a dump rake, and then bunched. Few if any farmers use a mechanical hay loader.

The county agricultural agent estimates that about 50 percent of the farmers follow a rotation of corn, seeded to small grain in fall, and lespedeza and grass seeded in the small grain in spring to remain for 2 years. About 20 percent follow a similar rotation but substitute red clover for the grass and lespedeza; and about 20 percent plant corn, rest the land for 2 years, and plant corn again.

Table 4 gives the dates for sowing or planting and of harvesting the important crops in the county.

TABLE 4.—*Dates for sowing or planting and of harvesting the important crops in Grainger County, Tenn.*

Crop	Planting[1]	Harvesting	Crop	Planting[1]	Harvesting
Corn	April 20—May 10	September and October.	Tomatoes (plants): Early	May 1–15	July 15–Aug. 15.
Wheat	Oct. 10—20	June.	Late	June 15–30	September.
Oats: Winter	Sept. 15—Oct. 1	Do.	Potatoes	Jan. 1–Mar. 15	June and July.
Spring	Mar. 1–15	Late in May for hay.	Sweetpotatoes (plants)	Apr. 20–May 15	October.
Barley	Sept. 20–Oct. 7	Early in June.	Sorghum	May 15–June 15	Late in September.
Rye	Oct. 1–20	Do.	Red clover	Aug. 1–Sept. 10 or Mar. 1–15	In June for hay.
Tobacco	Seeded in beds Feb. 1–Mar. 1; set in field May 10–June 15	Early in September.	Alfalfa	Aug. 20–Sept. 10 or Mar. 1–20	Early in May, July, and September.
			Lespedeza	Mar. 1–30	August and September.

[1] Planting dates from C. A. Mooers (7).

The total expenditure for fertilizer and lime in 1939, according to census figures, was $43,830. The percentage of farms using fertilizer and lime has increased because of the decrease in fertility; long use of the land; increase in tobacco acreage, all of it requiring fertilization; increase in pasture and leguminous hay crops, which generally requires both lime and phosphate; and education of the farmers. Most of the fertilizer is bought factory-mixed by individual farmers from the dealers and used under tobacco, corn, wheat, and truck crops. Phosphate fertilizers (mainly 16-percent phosphoric acid) are used under corn, small grain, and hay crops. Phosphates, in combination with comparatively heavy applications of crushed lime, are applied to legumes and grasses. The ready-mixed fertilizers for small grain, tobacco, and truck crops are 0–10–4[4] and 3–8–5. Some nitrate of soda is used for side-dressing some crops.

LIVESTOCK AND LIVESTOCK PRODUCTS

The number and value of livestock on farms in stated years are shown in table 5.

TABLE 5.—*Number and value of livestock on farms in Grainger County, Tenn., in stated years*

Livestock	1910		1920		1930		1940	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Horses	2,866	$313,525	2,842	$366,670	1,980	$137,726	[2]2,015	[1]$195,494
Mules	1,585	201,384	1,945	257,150	1,494	129,799	[1]1,492	[1]180,908
Cattle	9,053	213,639	9,629	423,090	8,923	371,359	9,677	334,770
Swine	9,187	60,857	9,580	112,723	6,572	66,570	[2]6,391	[2]42,852
Sheep	4,557	15,140	1,835	15,823	3,425	24,595	[3]657	[3]3,977
Goats	97	339	47	177	88	300	[3]61	[3]119
All poultry	[1]95,886	[1]52,869	115,868	111,259	[4]87,931	[4]72,103	[2]86,675	[2]43,473

[1] Over 3 months old, April 1.
[2] Over 4 months old, April 1.
[3] Over 6 months old, April 1.
[4] Chickens over 3 months old, April 1.

Horses have declined markedly in number since 1920, whereas the number of mules has decreased only slightly. There were 2,015 horses and 1,492 mules over 3 months old as of April 1, 1940. The Percheron is the principal breed of horses. The county agricultural agent estimates that nearly enough work animals are raised on the farm for replacement.

[4] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

There has been no great change in the total number of cattle since the first census figures. By 1940, however, the number had increased to 9,677. There were 4,386 cows and heifers over 2 years old kept mainly for milk and 453 kept mainly for beef. Most of the dairy cattle are grade Jersey. Although much of the dairy products are consumed at home, the sale of dairy products, mostly marketed locally or in Knoxville, accounts for about 6 percent of the total farm income. Only 26 farms are classified as dairy farms in the 1940 census. Most of the beef cattle are Herefords or grades of this breed.

In 1940 the total number of hogs was only 6,391, or an average of 2.6 a farm. Most of the hogs are purebreds or grades of the Poland China or Duroc-Jersey, which are consumed on the farm or marketed locally. In 1940 the number of sheep and lambs over 6 months old was 657, most of them grades or purebreds of the Hampshire or Shropshire breeds. The lambs and wool are marketed principally outside the county. Many farms keep a small flock, but very few specialize in sheep.

Nearly all farms have a small flock of poultry, which furnishes not only food for the home but about 20 percent of the total farm income. In 1940 there were 84,287 chickens over 4 months old, or an average of 34 to a farm. A few turkeys, geese, and ducks are raised. Rhode Island Red, Plymouth Rock, and White Leghorn are the principal breeds of chickens.

The total expenditures for feed on 1,069 farms, according to census figures, was $50,467. The county agricultural agent reports that cottonseed meal, chicken-feed concentrates, tankage, and wheat bran make up the bulk of feed purchased.

LAND USE

Practically all the land in the area was originally in forest, but after the white man began to settle there, much of it was cleared and its use shifted to agriculture. Most of the agricultural expansion took place before 1880. At that time 45.4 percent of the county was cleared land, and in 1940, 47.6 percent. Most of the area now in forest is land poorly suited to agricultural use, chiefly because of low fertility, unfavorable moisture relations, and steep slope or extreme stoniness. Land in farms in 1940 totaled 159,686 acres divided as follows: Cropland harvested, 45,145 acres; crop failure, 470; cropland idle or fallow, 5,435; plowable pasture 42,487; woodland, 45,940; and all other farm land, 20,209 acres.

The total area in farms since 1880 ranged from a high of 96.5 percent in 1880 to 80.5 in 1940, and the number of farms increased from 1,536 to 2,451. During that period the rural population remained relatively stable. The average size of farms has shown a decline each census year from a high of 123 acres in 1880 to 65.2 acres in 1940. The acreage of improved land per farm ranged from 58.1 in 1880 to 30 in 1940. About 57 percent of the farms range from 20 to 180 acres, about 37 percent are less than 30 acres, and 6 percent are 180 acres or more.

Since 1879 there have been some significant changes in the use of land for agriculture. The most notable shift has been a decrease of acreage in grain crops and an increase in hay and forage. In 1879 the total acreage in corn, wheat, oats, barley, and rye was 49,467; whereas in 1939 it was only 26,471. During the same period the total acreage used for

hay and forage increased from 1,527 in 1879 to 12,828 in 1939. There has also been a large increase in the acreage planted to tobacco—44 acres in 1919 to 2,284 in 1939.

FARM TENURE AND INVESTMENT

According to the 1940 census, full owners operated 1,503 farms; part owners, 224; managers, 3; and tenants, 721. Nearly all the tenants are share tenants, although a few rent for cash. The three common systems of share renting are (1) tenant furnishes labor only and receives half the tobacco crop and a third of the other crops; (2) tenant furnishes labor, work animals, and half the fertilizer and receives two-thirds of the tobacco crop and half of all other crops; (3) tenant furnishes all the labor, work animals, equipment, fertilizer, and seed and receives two-thirds of all crops.

There has been a general decrease both in the total amount spent for labor and in the number of farms reporting such expenditures. In 1909, 48.2 percent of the farms reported expenditures of $70,531; but in 1939, 34 percent reported $60,496. Farm labor, consisting largely of local white people, is considered fair to good and is moderately plentiful. Wages generally range between $0.75 and $1.25 a day, the employer furnishing one or two meals a day. Many of the regular farm laborers are furnished a house, fuel, garden plot, and pasture for one cow and receive $0.50 to $1 a day for the days they actually work.

The average value of farm property increased from $1,121 in 1880 to $2,154 in 1940. Part of this increase is due to an increase in the general price level; some is due to improvements on the land, as buildings and fences. The relative value of livestock per farm has decreased from about 19 percent in 1890 to about 13 percent in 1940. The relative value of implements and machinery has changed but little and has never exceeded 4.4 percent of the investment. In 1940, land represented about 56 percent of the total farm investment; buildings about 27 percent; implements about 4 percent; and domestic animals about 13 percent.

In 1940 there were 35 tractors, 166 trucks, and a few combines in the county. An ordinary farm is generally equipped with a turning plow, a wagon, a drag harrow, 2 one-horse cultivators, a bull-tongue plow, a single-row corn planter, a mowing machine, a dump rake, and a hand tobacco sprayer. Grain binders, threshers, and combines are owned by a few farmers who do custom work for their neighbors.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field and the recording of their characteristics, particularly in regard to the growth of various crops, grasses, and trees.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings made, and highway or railroad cuts and other exposures studied. Each excavation exposes a series of distinct soil layers, or horizons, termed collectively the soil profile. Each horizon, as well as the underlying parent material, is studied in detail, and the color, structure, porosity, consistence, texture, and the content of organic matter, roots, gravel, and stone are noted.

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The chemical reaction of the soil and its content of lime and salts are determined by simple tests.[5] Other features taken into consideration are the drainage, both internal and external, the relief, or lay of the land, and the interrelation of soil and vegetation.

The soils are classified according to their characteristics, both internal and external, with special emphasis upon the features that influence the adaptation of the land for the production of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units, the principal three of which are (1) series, (2) type, and (3) phase. Some areas that have no true soil—as Limestone outcrop and Rough gullied land (shale and sandstone residuum)—are termed (4) miscellaneous land types.

The series is a group of soils having the same genetic horizons, similar in their important characteristics and arrangement in the profile and having similar parent material. Thus, the series comprises soils having essentially the same color, structure, natural drainage, and other important internal characteristics and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The series are given geographic names taken from localities near which they were first identified. Decatur, Fullerton, Clarksville, and Muskingum are names of important soil series in Grainger County.

Within a soil series are one or more types, defined according to the texture of the upper part of the soil. Thus, the class name of this texture—sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, or clay—is added to the series designation to give a complete name to the soil type. Except for the texture of the surface soil, these types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the unit to which agronomic data are definitely related. In comparisons of the type and phases of that type, to avoid the repetition of their complete names, the type is sometimes referred to by abbreviation either as the type, the normal soil, the normal type, or the typical soil. Bruno fine sandy loam and Bruno loamy fine sand are types within the Bruno series.

A soil phase is a variation within the type, differing from it in some minor feature, generally external, that may be of special practical significance. For example, within the normal range of relief for a soil type some areas may be adapted to the use of machinery and the growth of cultivated crops and others may not. Differences in relief, stoniness, and degrees of accelerated erosion may be shown as phases. Even though no important differences may be apparent in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such instances the more sloping parts of the soil type may be segregated on the map as a sloping or a hilly phase. Similarly, some soils having differences in stoniness may be mapped as phases even though these differences are not reflected in the character of the soil or in the growth of native plants.

[5] The reaction of the soil is its degree of acidity or alkalinity, expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality; higher values, alkalinity; and lower values, acidity. Indicator solutions are used to determine the chemical reaction. The presence of lime is detected by the use of a dilute solution of hydrochloric acid.

Texture is the relative quantities of clay, silt, and various grades of sand that make up the soil mass. Light-textured soils contain much of the coarser separates (sands), and heavy-textured soils contain much clay. Structure is the natural arrangement of the soil material in aggregates, or structural particles, or masses. Consistence refers to such conditions as friability, plasticity, stickiness, hardness, compactness, toughness, and cementation. Permeability and perviousness connote the ease with which water, air, and roots penetrate the soil. The surface soil ordinarily refers to the layer that usually extends to a depth of 6 to 12 inches. The subsoil is the deeper and usually heavier textured layer that is usually of a uniform color in well-drained soils. The substratum is beneath the subsoil and is characteristically splotched or mottled with two or more colors. Bedrock, as used here, is consolidated rock upon which the substratum rests. In a practical sense, the degree of acidity may be thought of as the degree of poverty in lime (available calcium), or as indicating the quantity of lime that should be applied for certain crops. An alkaline soil in this county is rich in available calcium, and a neutral soil contains a sufficient quantity for any crop commonly grown.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS OF THE COUNTY

The well-developed soils of the county, which are confined to the uplands and the older terrace lands, have formed in an environment of moderately high temperature, relatively heavy rainfall, and forest cover. Despite the fact that environmental factors of climate and vegetation were similar over most of the county, the well-developed soils differ widely among themselves in morphology, fertility, and productivity. During the history of cultivation, erosion and other artificially stimulated processes of impoverishment have further intensified local differences in productivity and in workability and conservability.

Steepness of slope, stoniness, shallowness to bedrock, low fertility, and loss of material by erosion have made about 40 percent of the county poorly suited to crops or pasture. Taking the average of the Great Valley of East Tennessee as a standard, it is estimated that about 6.5 percent of the land suitable for cultivation is relatively high in natural fertility and productivity, about 35.5 percent is medium, and about 58 percent is relatively low. Most of the soils are deficient in lime even though many of them have developed from materials weathered from limestone; the lime having been leached out during the processes of rock weathering and soil development. The quantity of organic matter is not high in any of the soils even in the virgin state, but there were and still are relatively wide differences in the content in the different soils of the area.

The tilth of most soils is favorable except on some of the silty clay loams, which are subject to puddling, surface baking, and clodding when tilled under unfavorable moisture conditions. With relatively few exceptions, this unfavorable nature is due to the exposure of the more intractable subsoil material by accelerated erosion.

TABLE 6.—*Characteristics of soil series in Grainger County, Ten*

UPLANDS

Series	Parent material	Dominant relief	Internal drainage	Surface soil				Sub	
				Color	Consistence	Texture[1]	Thickness[2]	Color	Consistence
							Inches		
Decatur	Material residual from weathering of—High-grade limestone[5].	Undulating to rolling.	Free to medium.	Brown to dark brown.	Mellow, granular.	Silt loam	8–12	Red to dark red.	Dense but permeable
Dewey	High-grade dolomitic limestone.	do	do	Brown to grayish brown.	Mellow	do	10–14	Red to brownish red.	Firm but friable.
Fullerton	Cherty dolomitic limestone.	Rolling to hilly.	do	Brownish gray.	do	Silt loam to fine sandy loam.	8–14	Yellowish red or light red.	do
Clarksville	do	do	do	Light gray	Cherty to mellow.	do	8–16	Yellow	do
Bolton	High-grade dolomitic limestone.	do	do	Light reddish brown.	Mellow	Silt loam	6–12	Brownish red	Friable
Talbott	Clayey limestone.	Undulating to hilly.	Medium to slow.	Grayish brown.	do	do	6–8	Yellowish red	Compact, sticky, and plastic.
Colbert	do	Undulating to rolling.	Very slow to slow.	Brownish gray.	do	do	4–8	Yellow mottled with gray.	Tough, plastic.
Sequoia	Interbedded limestone and shale.	do	Fair to slow.	Grayish brown to brownish gray.	do	do	6–12	Reddish yellow.	do
Armuchee	do	Hilly to steep	do	Yellowish gray.	do	do	4–6	do	do
Montevallo	Acid shale	Undulating to rolling.	Free to rapid	do	do	do	6–8	Yellow	Moderately plastic.
Muskingum	Acid sandstone and shale.	Hilly to steep	do	Grayish yellow.	Loose	Sandy loam	8–12	do	Friable
Hector	do	do	do	do	do	Fine sandy loam.	6–12	Yellowish red	do

Lehew	Interbedded acid sandstone and shale.	do	do	Purplish gray.	Mellow	Stony very fine sandy loam.	5–10	Purplish yellow to purplish brown.	do
				COLLUVIUM AND LOCAL ALLUVIUM					
	Colluvium and local alluvium chiefly from—								
Emory	Decatur, Dewey, Bolton, and high-grade Fullerton soils.	Gently sloping to sloping.	Free to rapid.	Brown to dark brown.	Mellow	Silt loam	10–20	Reddish brown or yellowish brown.	Firm but friable.
Greendale	Fullerton and Clarksville soils.	do	Free to medium.	Brownish gray to grayish brown.	do	do	8–12	Brownish yellow.	do
Abernathy	Decatur, Dewey, Bolton, and high-grade Fullerton soils.	Nearly level (depressional).	do	Brown mellow silt loam to a depth of about 30 inches, below which the materi mottled.					
Ooltewah	Decatur, Dewey, Bolton, Fullerton, and Clarksville soils.	do	Slow	Grayish-brown silt loam to a depth of about 15 inches, below which is mottle silt loam or silty clay loam.					
Guthrie	do	do	Very slow	Gray silt loam to a depth of about 6 inches, below which the material is gray brown; more plastic with depth.					
Leadvale	Montevallo, Lehew, Armuchee, and finer textured Muskingum soils.	Gently sloping to sloping.	Medium to slow.	Brownish gray.	Mellow	Silt loam	8–10	Yellow	Firm
Jefferson	Muskingum	do	Free to rapid.	do	do	Stony fine sandy loam.	5–7	do	Friable
Hayter	Muskingum and Armuchee soils.	Gently to strongly sloping.	do	Brown	do	Loam	12–18	Reddish brown or yellowish brown.	do

See footnotes at end of table.

TABLE 6.—*Characteristics of soil series in Grainger County, Tenn.*—C

TERRACES

Series	Parent material	Dominant relief	Internal drainage	Surface soil				Sul	
				Color	Consistence	Texture[1]	Thickness[2]	Color	Consistenc
							Inches		
Cumberland	Alluvium comprised of material derived chiefly from—Limestone	Undulating to sloping.	Medium to free.	Dark brown	Mellow	Silt loam	10–16	Red to dark red.	Dense but permeable
Etowah	do	do	do	Brown	do	do	8–12	Yellowish brown to reddish brown.	Friable
Waynesboro	Sandstone and shale.	do	do	Grayish brown.	do	Very fine sandy loam.	6–8	Reddish yellow to yellowish red.	Firm but friable.
Holston	do	Undulating to strongly sloping.	do	Light gray	Loose	do	10–12	Yellow	do
Sequatchie	do	Undulating to sloping.	Free to rapid	Light brown	do	Fine sandy loam.	8–12	Yellowish brown.	Friable
Tyler	do	Nearly level	Very slow	Light gray	Mellow	Very fine sandy loam.	10–16	Grayish yellow to gray.	Compact

BOTTOM LANDS

Huntington	Alluvium comprised of material derived chiefly from—Limestone	Nearly level	Free to rapid	Brown mellow silt loam to a depth of about 15 inches, below which the material and finer textured.
Roane	Cherty limestone.	do	Free to medium.	Light-brown silt loam grading to yellowish-brown silty clay loam, underlain b chert.

Lindside	Limestone	do	Slow	Grayish-brown mellow silt loam to a depth of about 16 inches, underlain by brown silty clay loam.
Melvin	do	do	Very slow	Gray mellow silt loam, underlain at about 7 inches by gray mottled with yellow or silty clay.
Bruno	Sandstone and shale with some calcareous material.	do	Free	Light-brown loamy fine sandy to fine sandy loam; lighter colored and genera depth of about 20 inches.
Pope	Sandstone and shale.	do	do	Grayish-brown friable fine sandy loam to a depth of about 8 inches, below whic what finer textured material; mottled below 30 inches.
Philo	do	do	Slow	Light grayish-brown fine sandy loam to a depth of about 14 inches, underlain and brown sandy clay.
Atkins	do	do	Very slow	Gray fine sandy loam mottled somewhat with yellow and brown; below a de material is gray mottled with yellow and brown and finer textured.

[1] Texture where not affected appreciably by erosion.
[2] Thickness where not affected appreciably by erosion.
[3] Applies particularly to the part of soil profile directly below the surface soil, generally characterized by a uniform color and slightly finer t
[4] In general, statements apply to areas of approximate normal slope and not severely eroded.
[5] Limestone with a relatively low content of insoluble siliceous material.

The soils of the county differ widely in texture, consistence, reaction, fertility, moisture conditions, relief, and in degree of stoniness and erosion, all of which affect their productivity, workability, and conservability. They exhibit color hues of gray, yellow, brown, and red. The surface layer is mostly light gray, brownish gray, grayish brown, or brown, and the subsoil layer of most soils is brown, yellow, or red. The small acreage of poorly drained soils has a gray subsoil.

Texture of the surface soil ranges from loamy fine sand to silty clay loam. Fine sandy loams cover about a third; silty clay loams, about a third; silt loams, about a fourth; and very fine sandy loams and loams, about a seventh. About two-thirds of the fine sandy loams are stony; about half the silty clay loams have outcrops of limestone bedrock numerous enough to preclude tillage; about half the silt loams are cherty; and about a fifth of the loams are stony. In consistence, the soils range from the extreme friability of the Jefferson and Pope to the tough, sticky, and plastic consistence of the Colbert. With the exception of the Huntington, Bruno, Melvin, and Lindside, all soils are medium to very strongly acid in reaction. The relief, or lay of the land, ranges from level to very steep. About 5 percent is nearly level (less than 2-percent slope), 5 percent undulating (2- to 5-percent), 20 percent rolling (5- to 12-percent), 40 percent hilly (12- to 30-percent), and about 30 percent is steep or very steep (more than 30-percent slope). Only a very small part of this soil has a slope exceeding 70 percent.

The productivity of about half the area has been materially reduced by accelerated erosion. Of this part, a fourth has been very severely damaged. Less than 1 percent is poorly drained. A fairly consistent relation is manifest between the productivity of the soils and the general well-being of the people living on the land.

Observations make it more or less apparent that the prevailingly productive soils support the more progressive agricultural communities, as expressed by good farmhouses and other farm buildings, good fences, ample farm equipment, good schoolhouses, churches, and local roads. These communities are where the Decatur, Bruno, Huntington, Emory, Hayter, Roane, Lindside, Greendale, Holston, Bolton, Cumberland, Waynesboro, Philo, and the mild slopes of Dewey, and Fullerton soils are extensive. On the other hand, the more modest farmhouses and other buildings, poorer fences, small irregular fields, poorer schools, and churches will generally, but not always, be found where the soils are comparatively low in productivity and not well suited to the present agriculture. This is particularly true where the farms are on the Montevallo, Muskingum, Lehew, and Tyler soils, and the strong slopes of Clarksville, Fullerton, and Talbott.

Land conditions have not only influenced general agricultural development but also the type of agriculture. For example, the Bruno and Lindside soils, which are on the bottom lands, are particularly well suited to corn and are primarily so used. Where such soils are extensive the raising of livestock has increased. The Decatur, Dewey, Bolton, Hayter, Holston, and Fullerton have a wide range in suitability and are capable of supporting widely diverse types of farms. It is on these soils, in combination with the Bruno, Lindside, Roane, and Greendale, that the majority of the crop-specialty, animal-specialty, and a large number of general farms are located. On the other hand,

the majority of the subsistence farms are on Montevallo, Muskingum, Lehew, Jefferson, and the strongly sloping Clarksville, Fullerton, and Talbott soils. It is nevertheless true that some farmers on these latter soils, by good management and thrift, have developed their farms beyond what is ordinarily considered the subsistence level in this area.

SOIL SERIES AND THEIR RELATIONS

On the basis of differences in color, consistence, structure, and depth, the soils of the county have been classified in 35 series, 119 soil types and phases, and 9 miscellaneous land types. The series are placed into four groups, on the basis of the position the soils normally occupy on the broad landscape, as follows: (1) Uplands, (2) colluvium and local alluvium, (3) terraces, and (4) bottom lands. The soils of the uplands have been formed from the residuum of the underlying rock, or from material that has not been moved by water or gravity. Most of these lie above colluvial land, terraces, and bottom land. The colluvium and local alluvium are in areas where rocks and soil material have accumulated at the foot of mountains, ridges, or hills. Terrace lands and bottom lands are made by the action of water. The terrace lands are benchlike areas that border the bottom lands but occupy higher positions and are not subject to flooding, whereas the bottom lands comprise areas along the streams that are subject to flooding.

The soil series are grouped according to their characteristics in table 6.

SOILS OF THE UPLANDS

Soils of the uplands occupy 85 to 90 percent of the county. They are developed from various grades of limestone, from interbedded limestone and shale, and from interbedded acid sandstone and shale.

The Decatur, Dewey, Fullerton, Clarksville, Bolton, Talbott, and Colbert series are developed from limestone material. The soils of the Decatur, Dewey, Fullerton, and Clarksville series differ from each other largely in the color of surface soil and subsoil, although there are other significant differences. The surface soil of the Decatur is brown to dark brown; the Dewey, brown to grayish brown; the Fullerton, brownish gray; and the Clarksville, light gray. The subsoil of the Decatur is red to dark red; the Dewey, red to brownish red; the Fullerton, yellowish-red or light red; and the Clarksville, yellow. The Decatur soils are practically chert free, the Dewey have very little chert, the Fullerton a moderate quantity, and the Clarksville very much. The Decatur soils are the most fertile of these four series, the Dewey second, the Fullerton somewhat lower, and the Clarksville lowest. Bolton soils are closely associated with the Fullerton but are redder and differ from the Decatur and Dewey in having a more open, permeable subsoil and a more sloping surface, but are somewhat less fertile than the Dewey. The Talbott and Colbert are characterized by a tough, plastic subsoil, but the Colbert have a yellower subsoil, a more sticky, plastic consistence, and shallower depth to bedrock.

The Sequoia and Armuchee soils are developed from material derived from interbedded limestone and shale. The Sequoia are smoother, and, though their depth is relatively shallow to bedrock, it is greater than in the Armuchee. They are also more productive and have a greater

suitability for agricultural use. The Montevallo, developed from material derived from acid shale, are less productive and shallower to bedrock than the Sequoia. The Muskingum, Hector, and Lehew are developed from material derived from acid sandstone and shale or interbedded acid sandstone and shale. All are shallow to bedrock, have a hilly to steep relief, and are of low fertility. The first two are grayish yellow and the Lehew purplish gray.

DECATUR SERIES

Soils of the Decatur series are well drained, both internally and externally, are acid in reaction, are permeable, have a fairly high water-holding capacity, and are naturally very fertile and productive. The prevailing relief is undulating to rolling. They normally occur on valley troughs, and the parent material is residuum from high-grade limestone. The native vegetation was forest, mainly oak, hickory, maple, and chestnut.

In uneroded fields the surface soil to a depth of 8 to 12 inches is brown to dark-brown mellow silt loam, with a granular structure underlain by about 16 inches of brownish-red friable silty clay loam. The 3- to 6-foot subsoil is red to dark-red dense but permeable silty clay, somewhat plastic when wet but moderately friable under normal moisture conditions. This material crumbles readily into soft and easily crushed granular aggregates. Most of the aggregates are brown, but when crushed the material is red. The underlying parent material is firm tough silty clay, predominantly yellow but splotched with rust brown and some gray. Bedrock limestone is at a depth of 15 feet or more, although there are very occasional outcrops. Shaly material is intermixed with the silty clay below a depth of 5 or 6 feet in some places.

Most of the Decatur soils have been under cultivation for a long time, and much of the original surface soil has been lost. Under such conditions, freshly plowed fields have a red surface, and the structure of the surface soil is less favorable for crops and cultivation.

DEWEY SERIES

Soils of the Dewey series are well drained, permeable, and have a fairly high water-holding capacity. They are acid but relatively high in natural fertility and productivity. The prevailing relief is undulating to rolling. The parent material is residuum from high-grade dolomitic limestone. The native vegetation was forest, mainly oak, hickory, maple, and chestnut. In uneroded fields these soils have a surface layer of mellow brown to grayish-brown silt loam 10 to 14 inches thick. This material is underlain by red to brownish-red firm but friable silty clay 40 to 50 inches thick. The substratum is yellowish-red silty clay splotched with yellow, brown, gray, dark brown, and red. This layer is usually moderately sticky and plastic. Bedrock limestone is ordinarily at a depth of 15 to 25 feet below the surface.

FULLERTON SERIES

The Fullerton soils are on rolling and hilly cherty ridges. They are well drained, strongly acid, moderately cherty, and moderately productive. The parent material is residuum from cherty dolomitic lime-

stone. The native vegetation was forest, mainly of deciduous trees.

In uneroded fields the surface soil is brownish-gray and ranges in thickness from 8 to 14 inches. The subsoil is usually yellowish-red or light red and ranges in thickness from 25 to 40 inches. Underlying this is the substratum layer of reddish-yellow material mottled with yellow, red, brown, and gray. These layers normally have a moderate quantity of chert fragments scattered throughout. The chert content of the plow layer in about two-thirds of the acreage of these soils is high enough to interfere materially with tillage operations. The parent rock is dolomitic limestone, which in many places has beds of sandstone. The depth to bedrock in most places is more than 20 feet.

The suitability of these soils for agricultural use depends a great deal upon the relief and to some extent upon chertiness and degree of accelerated erosion. Where they have a mild relief and are not very cherty or badly eroded, they have a wide range of suitability for different uses, but where they have strong relief, are very cherty, or are severely eroded, their suitability is correspondingly narrow. In general they are less productive than the Dewey soils, but are less susceptible to erosion.

CLARKSVILLE SERIES

Soils of the Clarksville series are well drained, strongly acid, cherty, and rather low in natural productivity. They occupy the rolling, hilly, and steep areas on the cherty ridges where the parent rock is usually very cherty or sandy dolomite (pl. 3, *B*). The native vegetation was forest, mainly of deciduous trees.

In uneroded fields these soils have a light-gray surface soil, 8 to 16 inches thick, underlain by a subsoil layer of yellow or reddish-yellow material, 16 to 20 inches thick. The substratum consists of yellowish-red or reddish-yellow material mottled with red, yellow, brown, and gray. This layer, which is 20 to 40 feet thick, overlies cherty dolomitic limestone. Chert fragments are usually abundant in all these layers.

A much smaller proportion of these soils is eroded than in the Fullerton, but a greater proportion is wooded, and the cherty and somewhat more permeable nature of the subsoil makes them less subject to erosion.

As compared with the other soils developed from material weathered from limestone, these are the lowest in natural fertility and productivity. Their immediate response to proper fertilization is generally good but not so lasting as in the Decatur, Dewey, and Fullerton.

The suitability of the Clarksville soils to different uses depends upon the relief, and to a lesser extent upon the content of chert and the degree of erosion. Where the relief is mild, they can be used for practically all the common crops, but only moderate yields are to be expected. Where the relief is strong, they are very poorly suited to crops and only moderately well suited to pasture.

BOLTON SERIES

Soils of the Bolton series are well drained, permeable, strongly acid, slightly cherty, productive soils associated with the Fullerton on the dolomitic ridges (pl. 3, *C*). The parent material is residuum from high-grade dolomitic limestone. The prevailing relief is rolling and hilly but ranges from undulating to steep. The native vegetation was

deciduous forest, consisting mainly of oak, hickory, chestnut, yellow-poplar, and maple. In moderately eroded fields these soils have a light reddish-brown mellow silt loam surface soil 6 to 12 inches thick. This material generally has a fluffy or slightly spongy feel. The subsoil is brownish-red friable silty clay 40 to 50 inches thick, and the substratum is yellowish-red silty clay splotched with yellow, gray, brown, and dark red. Bedrock limestone is at a depth of 25 to 30 feet. Chert fragments are usually scattered throughout the soil, but ordinarily the content is not high.

TALBOTT SERIES

The Talbott soils, occupying undulating to hilly areas in limestone valley troughs, have developed from clayey limestone. Internal drainage is fair; they are strongly acid, comparatively shallow over bedrock, have a compact, sticky, plastic subsoil, and are nearly chert free. Here and there are limestone outcrops. These soils were originally forested with deciduous species.

In uneroded fields the surface soil, 6 to 8 inches thick, is grayish-brown mellow silt loam. The 20- to 24-inch subsoil is yellowish-red, compact, sticky, and plastic silty clay having a fairly well-defined angular nutlike structure. The substratum resembles the subsoil but differs primarily in containing numerous yellow, gray, red, brown, and black mottlings and in having larger structural aggregates. In most places bedrock is about 5 feet below the surface.

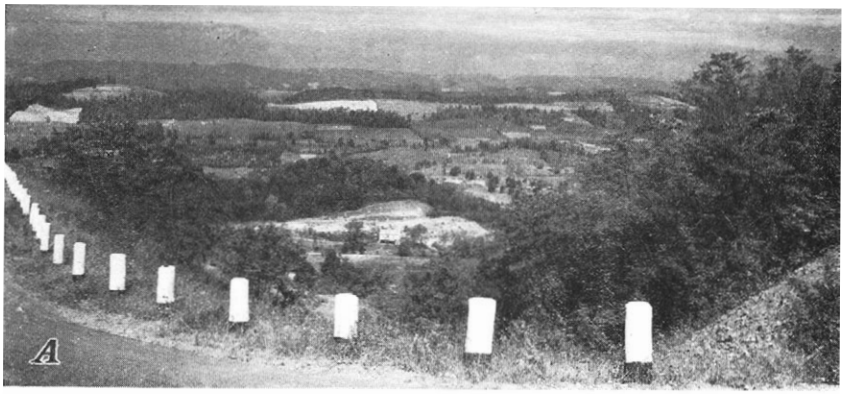
Owing largely to the heavy plastic nature of the subsoil these soils do not have so wide a range in suitability as the Dewey and are more exacting in their management requirements. Their suitability for different uses depends largely on slope and degree of erosion. On the milder slopes, where not badly eroded, they are fairly well suited to most of the crops commonly grown and to pasture.

COLBERT SERIES

The Colbert soils, the heaviest and finest textured soils in the county, have developed from limestone of high clay content. They are shallow to bedrock. Relief is undulating to rolling, and internal drainage is poor because of the very slowly permeable nature of the subsoil. These soils occur principally in limestone valleys associated with Talbott soils and stony land types. In uneroded fields the surface soil is generally brownish-gray mellow silt loam ranging from 4 to 8 inches thick. The 12- to 18-inch subsoil of tough plastic silty clay is yellow mottled with gray. In many places this layer continues to bedrock, but where it does not the intervening layer is similar but more highly mottled with gray and green. Flat limestone fragments are common in the soil profile, particularly in the lower part, and rock outcrops are not uncommon.

SEQUOIA SERIES

The parent material of the Sequoia soils is residuum from interbedded limestone and shale. Internal drainage is fair to slow. These soils are strongly acid and moderately productive in valley troughs. As limestone and shale in the bedrock vary from place to place, the depth over bedrock and the profile characteristics vary also. The surface



A, View from Clinch Mountain looking northwest across Clinch Valley and Copper Ridge. Talbott and Decatur soils predominate in Clinch Valley and Fullerton and Clarksville on Copper Ridge. All the soils overlying limestone vary widely in adaptation. Their fertility ranges from fair to moderately high, their slope from gently rolling to hilly, and their degree of stoniness from stone free to very stony. The relatively intricate capability pattern resulting from these variations is largely responsible for the patchy culture pattern.

B, A characteristic landscape of a more rolling part of the Copper Ridge section of Grainger County. Clarksville soils predominate here; the cherty silt loam, steep phase, occupies the wooded part and the cherty silt loam, eroded hilly phase, the building site and the field back of it. These soils are of low productivity and difficult to cultivate, and when frequently tilled they present a problem of conservation.

C, Fullerton and Bolton soils occupy the more rolling part of this landscape, and Emory silt loam the gentle slope in the foreground. Such areas are used for general farming; corn, small grain, hay, and rotation pasture are the chief uses for this particular tract. Woodland is on the smoother areas of the Fullerton soils.

A, Long continued use of Armuchee soils on slope for row crops results in a serious loss of soil material and the development of numerous gullies too deep to be crossed by farm machinery, whereas virgin areas may be made to produce good pasture with little effort. Badly eroded areas may require special treatment to establish a good pasture cover, and those most severely eroded may be suited only to forest.

B, The larger well-drained sinkholes associated with the Fullerton, Dewey, and Decatur soils are occupied by Abernathy silt loam. This is a productive and easily worked soil and is not difficult to conserve. Row crops—tobacco, corn, alfalfa, and truck crops—are commonly grown several years in succession.

is undulating to rolling. The profile resembles that of the Talbott in color and consistence.

In uneroded fields the surface soil is grayish-brown to brownish-gray silt loam 6 to 12 inches thick. This layer is underlain by moderately tough and plastic silty clay, ranging in thickness from 20 to 30 inches, which is usually reddish yellow but may be yellow or yellowish red. The substratum is usually similar to the subsoil in consistence, but is yellowish red and splotched with red, yellow, gray, and brown. All these layers usually contain varying quantities of small shale fragments, and where severely eroded the proportion of these fragments in the surface soil is high. Bedrock usually averages 25 to 50 inches below the surface.

The smoother, less eroded areas are fairly well suited to agricultural uses, and their productivity approximates that of the Fullerton. The more sloping or eroded areas are much less well suited to agricultural use.

ARMUCHEE SERIES

Soils of the Armuchee series occupy hilly, steep, and very steep areas on ridge slopes underlain by interbedded limestone and shale (pl. 4, *A*). They are similar to the Sequoia soils in character of parent material but differ from them especially in development of profile, depth to bedrock, and slope.

Although rather wide variations were allowed in this series, the surface inch in virgin areas is dark-gray silt loam where typically developed. This layer is underlain by about 5 inches of yellowish-gray silt loam. The subsoil is reddish-yellow moderately tough and plastic silty clay 10 to 20 inches thick. The substratum is usually similar in consistence and color but is splotched with red, gray, yellow, and brown and has numerous small shale fragments. The thickness of this layer is generally about 10 inches. The depth over bedrock averages about 30 inches, but bedrock outcrops are common though not abundant.

Because of the predominant southeastward dip of the underlying interbedded limestone and shale, narrow outcrops of limestone are more common on slopes facing northwest than on those facing southeast, a great many of the latter being entirely free of surface exposures of the limestone beds.

These soils are not suited to crops requiring tillage, because of their strong relief and susceptibility to erosion. Where not too badly eroded, they are fairly well suited to pasture.

MONTEVALLO SERIES

Montevallo soils, developed from acid shale residuum, are well drained, shallow over bedrock, strongly acid, and relatively low in natural productivity, fertility, and organic matter. The slope ranges from undulating to rolling, but practically all the soils are easily injured by accelerated erosion. These soils generally occur in long comparatively narrow strips, chiefly in geographic association with Muskingum, Sequoia, and Decatur. Where uneroded, the surface soil is usually a 6- to 8-inch yellowish-gray silt loam. The 8- to 16-inch subsoil is a yellow silty clay. Bedrock, consisting of grayish-yellow, bluish-gray, or variegated acid shale, usually occurs at a depth of 12

to 24 inches. Chiefly because of low fertility and shallow depth to bedrock, these soils are not well suited to agricultural use.

MUSKINGUM SERIES

Muskingum soils are developed from acid sandstone and shale. They have hilly to steep relief and good internal drainage and are comparatively shallow to bedrock, strongly acid, and generally stony. They are on the sandstone and shale ridges and on the southeastern slope of Clinch Mountain. These soils do not have well-developed profiles. In virgin areas the surface inch is usually a dark-gray very friable sandy loam underlain by 8 to 12 inches of grayish-yellow loose sandy loam. The 15- to 20-inch subsoil is usually a yellow friable sandy clay or sandy clay loam. Beneath the subsoil the material is similar but is splotched with yellow, red, gray, and brown, and has a rather high proportion of shale and sandstone fragments. The depth to bedrock averages about 30 inches. Owing chiefly to strong relief, low natural fertility, stoniness, and shallow depth over bedrock, these soils are not considered suited either to crops or to pasture.

HECTOR SERIES

Like those of the Muskingum series, the Hector soil is developed from acid sandstone and shale. It is shallow to bedrock and is associated with the Muskingum soils, but differs from them chiefly in having a yellowish-red rather than yellow sandy clay subsoil. The 6- to 12-inch surface layer is grayish-yellow fine sandy loam, and the subsoil is yellowish-red friable fine sandy loam. Sandstone fragments occur throughout the profile, and bedrock is at a depth of a few inches to 2 feet or more. This soil is not well suited to agricultural use.

LEHEW SERIES

Like the Muskingum, the Lehew soils are shallow to bedrock, stony, strongly acid, excessively drained, and derived from acid sandstone and shale and have steep and hilly relief. They differ, however, chiefly in being developed from residuum of varicolored sandstone and shale in which purple predominates, and in having tints of purple in the profile. The 5- or 6-inch surface layer is purplish-gray stony very fine sandy loam, and the underlying material is purplish-yellow to purplish-brown friable fine sandy loam. Bedrock shale is at a depth of 15 to 20 inches or less. Owing to their unfavorable characteristics, these soils are not considered suited either to crops or to pasture.

SOILS OF COLLUVIUM AND LOCAL ALLUVIUM

The soils developed from colluvium and local alluvium carried from adjacent high-lying soils occupy about 6 percent of the county. They occur on foot slopes and depressions and along gentle draws.

The Emory, Greendale, Abernathy, Ooltewah, and Guthrie soils are developed on material washed from soils developed from limestone residuum. The Emory and Greendale are on colluvial slopes, and the Abernathy, Ooltewah, and Guthrie are on local alluvium in depressions, as sinkholes. The parent rock of the Emory material is high-grade limestone, whereas that of the Greendale material is cherty limestone. The soils of the Abernathy series are well-drained, the Ooltewah intermediately drained, and the Guthrie poorly drained.

The Leadvale and Jefferson soils are formed on material washed from soils developed from material derived from acid sandstone and shale residuum. The Leadvale material is chiefly from shale and the Jefferson from sandstone. The Hayter are developed on a mixture of material washed from soils underlain by sandstone, shale, and limestone or a mixture of material from sandstone and shale that has been subject to the influence of lime-bearing water.

EMORY SERIES

The material from which the Emory soils have developed has washed largely from the Decatur, Dewey, and Bolton soils and the redder areas of the Fullerton. This material has accumulated at the foot of slopes, and in many places it is in the form of alluvial fans and cones. The separate areas are small as is also the aggregate area. The 10- to 20-inch surface soil is brown to dark brown, and the 15- to 30-inch subsoil is reddish brown or yellowish brown. The depth of the accumulated material varies but is at least 18 inches and usually more than 36 inches. These soils are fertile, well drained, and gently sloping to sloping. They are desirable for most crops, but are particularly good for tobacco.

GREENDALE SERIES

Greendale soils have accumulated at the foot of slopes, frequently in the form of alluvial fans and cones; the material from which they have developed has washed largely from the Fullerton and Clarksville. The separate areas are small as is also the aggregate. These soils have a brownish-gray to grayish-brown surface soil 8 to 12 inches thick and a brownish-yellow subsoil about 25 inches thick. The depth of the accumulated material varies but is at least 18 inches and usually more than 30. These soils are well drained, smooth, strongly acid, and medium in natural fertility. Though less fertile than the Emory soils, they are well suited to crops.

ABERNATHY SERIES

The Abernathy soil resembles the Emory in consisting of material that has washed chiefly from Decatur, Dewey, Bolton, and high-grade Fullerton soils. It differs from the Emory, however, in occupying depressions or sinks that have no external drainage, but it does have good internal drainage. There is little if any profile development. From the surface downward to a depth of 30 inches or more the soil is generally a brown mellow silt loam. It is fertile, easily worked and conserved, and productive of several of the more common field crops and pasture.

OOLTEWAH SERIES

Like the Abernathy, the Ooltewah soil occupies sinkholes and depressions, but differs from it in being intermediately drained. It is productive, smooth, and easily conserved, but impaired drainage limits its suitability for crops. To a depth of about 15 inches the surface soil is grayish-brown silt loam. The subsoil is a brownish-gray splotched with gray, brown, and yellow mellow silt loam or silty clay loam. The aggregate area is not great. The separate areas are small and are widely scattered throughout those parts where the soils are developed from material derived from limestone.

GUTHRIE SERIES

Like the Abernathy and Ooltewah soils, the Guthrie has accumulated in sinkholes and depressions. These three soils form a catena in which the Guthrie is the most poorly drained. The surface soil, 6 to 8 inches thick, is gray mellow silt loam underlain by a subsoil of gray silt loam mottled with yellow and brown. Ordinarily at depths of about 20 inches the material is gray plastic silty clay. The small areas are widely distributed throughout those parts where the soils are developed from material derived from limestone. The soil is nearly level and not subject to erosion, but its productivity is low and its suitability for agricultural use limited.

LEADVALE SERIES

The material from which the Leadvale soils have developed has been washed chiefly from adjoining areas of Montevallo, Lehew, Armuchee, and Muskingum very fine sandy loam. The areas are small to medium-sized and are at the foot of slopes—many of them in the form of alluvial fans and cones at the mouth of small drains. These soils are young and vary from place to place in degree of profile development, depending upon the length of time the material has lain in place. In most areas the surface soil is brownish gray and the subsoil yellow. In a few places these soils are not particularly well drained and are mottled at about 30 inches below the surface. They are strongly acid, fairly well drained, low in organic matter, about medium in natural fertility, and suited to most of the crops commonly grown in this area.

JEFFERSON SERIES

Soils of the Jefferson series are developed from material washed largely from adjoining areas of Muskingum soils. In most places this material is in the form of alluvial fans and cones. The aggregate area is not large. These soils generally have a brownish-gray surface soil 5 to 7 inches thick and a yellow sandy clay subsoil 20 to 25 inches thick. Varying quantities of sandstone fragments are on the surface and throughout the profile. These soils are well drained, strongly acid, low in organic matter, and relatively low in natural productivity.

HAYTER SERIES

The material from which the Hayter soils have developed has come chiefly from Muskingum and Armuchee soils developed over sandstone and shale and has been either mixed with material derived from limestone or influenced by lime-bearing water. Areas occur on the lower, more gently sloping parts of ridges below Muskingum and Armuchee soils and on colluvial-alluvial fans at the mouths of short drains emerging from areas of these soils. These soils are medium acid, well drained, and fertile. Their slope ranges from gently to strongly sloping, and the degree of stoniness varies greatly. The smoother, less stony areas are easily worked, easily conserved, and well suited to a wide variety of crops. To a depth of about 15 inches the surface layer is brown mellow loam. Below this to a depth of about 30 inches is reddish-brown or yellowish-brown friable clay loam. The underlying colluvial-alluvial material varies in texture, color, and quantity of stone. The soils of this series occupy only a small part of the county.

SOILS OF THE TERRACES

The present rivers and creeks once flowed at considerably higher levels and deposited gravel, sand, silt, and clay on their flood plains in the same manner they are doing now. During the progress of stream cutting over many years, the channel was gradually deepened, new flood plains were formed at the lower levels, but remnants of the old higher lying flood plains were left. These areas are now above the overflow stage of the present streams and constitute what is referred to as stream terraces, or bench lands. Geologically, they consist of general stream alluvium that now lies above the overflow stage of the present streams and are commonly called second bottoms, or benches.

For the most part these terrace lands lie adjacent to the present flood plains or bottom lands. The typical relief is nearly level or gently sloping, but many of the terraces are so old as to have been somewhat dissected by recent stream action and are now undulating or rolling.

The soils on the terraces and bench lands are generally well drained and acid, contain a few water-worn gravel, range from low to high in natural fertility, respond well to good management, and nearly all are adapted to crops. They comprise six series—Cumberland, Etowah, Waynesboro, Holston, Sequatchie, and Tyler. The first two are developed from alluvium washed largely from soils underlain by limestone, but the Cumberland have well-developed profiles and are notably red, whereas the Etowah has a less mature profile and is somewhat brown rather than red. The Waynesboro, Holston, Tyler, and Sequatchie have developed from material washed largely from land underlain by sandstone and shale. The first three have relatively mature profiles and are on high terraces; the Sequatchie is less mature and is on low terraces. Waynesboro soils have a grayish-brown surface and a reddish-yellow to yellowish-red subsoil; the Holston has a light-gray surface and a yellow subsoil; and the Tyler is poorly drained and has a light-gray surface and a mottled grayish-yellow to gray subsoil.

CUMBERLAND SERIES

Soils of the Cumberland series occupy the older stream terraces. The alluvium from which they are developed originated chiefly from limestone and has been in place long enough for a well-developed profile to have formed. These soils are well drained, medium acid, permeable, and relatively high in organic matter and have a fairly high water-holding capacity. The relief ranges from gently sloping to sloping. Except for the severely eroded areas, these soils are productive and well suited to general agricultural use. To a depth of about 14 inches the surface layer is dark-brown mellow silt loam, and the subsoil, extending to a depth of 30 to 50 inches, is red to dark-red dense but permeable silty clay. Below this is mottled red, yellow, gray, and brown silty clay. The thickness of the terrace material ranges from 3 to 15 feet.

ETOWAH SERIES

Although younger in development, the soil of the Etowah series is like those of the Cumberland in that it is on stream terraces, the material of which originated chiefly from limestone. The surface layer is lighter colored and the subsoil is less red. The surface soil is brown mellow silt loam, and the subsoil is yellowish-brown to reddish-brown friable

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silty clay loam to silty clay. This soil is well drained, medium to slightly acid, permeable, relatively high in organic matter, and has a fairly high water-holding capacity. As the relief is normally gently sloping, the soil is productive and not difficult to work and conserve.

WAYNESBORO SERIES

Soils of the Waynesboro series are developed on old high stream terraces, the material of which originated chiefly from sandstone and shale. These soils are well drained, permeable, strongly acid, and medium to low in organic matter. Except for the more sloping and most eroded parts, they are moderately productive and not difficult to work and conserve. The surface soil is grayish brown, and the subsoil to a depth of about 36 inches is reddish-yellow to yellowish-red sandy clay. Below this is splotched or variegated red, yellow, brown, and gray sandy clay. A variable quantity of quartzite gravel is on the surface and throughout the profile. The terrace material is 3 to 10 feet thick.

HOLSTON SERIES

The Holston soils have developed from material that originated chiefly from sandstone and shale. Like the Waynesboro they have developed on the older, higher lying terraces, and have well-developed profiles, but differ in having a light-gray surface soil and a yellow subsoil. There is a variable quantity of quartzite gravel on the surface and throughout the profile, and the thickness of the material ranges from 3 to 10 feet. The soils are well drained, strongly acid, and have a moderate water-holding capacity and good tilth. They are low in natural fertility but, except on the more sloping parts, are easily worked. The relief ranges from gently to strongly sloping.

SEQUATCHIE SERIES

The Sequatchie soil is developed on low stream terraces, the material of which originated chiefly from sandstone and shale. From the standpoint of profile development it is younger than the Waynesboro and Holston. To a depth of about 10 inches the surface layer is light-brown fine sandy loam, and the subsoil is yellowish-brown friable sandy clay loam. Below a depth of about 32 inches the material is mottled or variegated yellow, gray, brown, and red friable sandy clay loam. The soil is well drained, permeable, smooth, moderately fertile, and well suited to agricultural use. Some areas are subject to infrequent flooding.

TYLER SERIES

The Tyler soil has developed in nearly level or slightly depressional positions on the older, higher lying terraces, the material of which originated chiefly from sandstone and shale. It has a light-gray surface layer and a moderately tough grayish-yellow silty clay subsoil splotched with gray, yellow, and brown. The soil is normally very strongly acid, poorly drained, and low in organic matter and natural fertility. The relief is mild. Most areas are not naturally well enough drained to be suitable for most crops.

SOILS OF THE BOTTOM LANDS

Bottom lands refer to the nearly level areas along streams that are subject to flooding. The material giving rise to all the soils in the

bottom lands has been carried there by streams. Their character depends upon the character of the soils from which washed and the rate at which the water was moving when the material was deposited. The soils are all young and immature. The soils of the bottom lands are in two groups: (1) Those in which the material originated largely from limestone and (2) those in which the material originated largely from sandstone and shale. The Huntington, Roane, Lindside, and Melvin series are of the first group, and the Bruno, Pope, Philo, and Atkins are of the second.

HUNTINGTON SERIES

The soil of the Huntington series consists of material originating chiefly from limestone. It is predominantly brown and well drained but is subject to flooding. To a depth of about 15 inches the material is brown and permeable. Below this the color is generally lighter, and at a depth of about 36 inches, gray and yellow mottlings become common. The soil is smooth, fertile, and slightly acid or neutral. Its suitability for crops is not so broad as that of some of the more productive soils not on the bottom lands, but it is very productive of the crops to which suited.

ROANE SERIES

The Roane soil occupies the well-drained bottom land along the small streams draining Clarksville and Fullerton areas. It is lighter colored and more cherty than the Huntington. To a depth of about 12 inches the surface material is light-brown silt loam, below which is yellowish-brown silty clay loam. In most places a layer of angular chert fragments is at depths of about 30 inches or more below the surface. The soil is well drained, acid, and about medium in natural fertility. Most areas are subject to flooding, although there is considerable difference between the areas in the frequency of flooding.

LINDSIDE SERIES

The soil of the Lindside series consists of material originating chiefly from limestone. It is not so well drained as the Huntington. The surface layer of about 16 inches is grayish-brown silt loam underlain by mottled gray, yellow, and brown silty clay loam. Below a depth of 2 or 3 feet the material is moist most of the time, and all areas are subject to flooding. The soil is fertile, slightly acid to neutral, and has a nearly level surface. It is productive, but its suitability for agricultural use is limited by intermediate drainage conditions.

MELVIN SERIES

The soil of the Melvin series consists of material originating chiefly from limestone. It differs from the Huntington, Lindside, and Roane soils chiefly in being poorly drained. To a depth of about 7 inches the surface soil is gray and predominantly silt loam in texture. Below this is gray mottled with yellow and brown silty clay loam or silty clay. The soil is slightly acid to neutral, but it is less fertile than the Lindside and Huntington. Its suitability for agricultural use is limited by slow internal drainage and a decided susceptibility to overflow.

BRUNO SERIES

Soils of the Bruno series consist of material originating chiefly from sandstone and shale intermixed or influenced sufficiently by material from limestone to make them slightly acid or neutral. They differ from the Huntington soil chiefly in being lighter brown, coarser textured, and less fertile, and from the Pope in being more fertile and less acid. The 15- to 20-inch surface layer is light brown, and the underlying material is variable but generally lighter colored and finer textured. These soils are moderately fertile, well drained, and well suited to the production of many of the crops commonly grown. Most areas are commonly subject to overflow.

POPE SERIES

The soil type of the Pope series consists of material originating chiefly from sandstone and shale. It is well drained and differs from the Bruno soils chiefly in being more acid and less productive. The 8-inch surface layer is grayish brown, below which is brownish-yellow permeable material generally of a finer texture. The soil is suited to many of the commonly grown field crops, although its susceptibility to overflow limits its usefulness.

PHILO SERIES

The soil of the Philo series consists of material originating chiefly from sandstone and shale. It differs from the Pope chiefly in being less well drained. To a depth of about 14 inches the surface material is light brownish gray, below which is mottled gray, yellow, and brown sandy clay loam or sandy clay that is dominantly gray below a depth of 30 inches. Internal drainage is intermediate, and practically all areas are subject to overflow. This soil is relatively low in fertility but is suitable for certain crops and for pasture. Proper fertilization is necessary for good yields. The Philo series is one of the more extensive of the bottom lands, and the areas are widely distributed.

ATKINS SERIES

The soil of the Atkins series consists of material originating chiefly from sandstone and shale. It differs from the Pope and Philo soils chiefly in being more poorly drained. To a depth of about 8 inches the surface material is predominantly gray and permeable. Below this is gray mottled with yellow and brown fine-textured material that is less permeable than the surface layer. Internal drainage is very slow, and all areas are commonly subject to flooding. The soil is medium to strongly acid, low in fertility, and poorly suited to agricultural use other than pasture unless artificially drained.

DESCRIPTIONS OF SOIL UNITS

In the following pages the soil types, phases, and land types are described in detail and their agricultural relations discussed. Their location and distribution are shown on the accompanying map, and their acreage and proportionate extent are given in table 7.

Abernathy silt loam.—A dark-brown well-drained soil occurring in depressions or sinkholes in areas underlain by limestone (pl. 4, *B*). It consists of material washed chiefly from red fertile soils underlain by

TABLE 7.—*Acreage and proportionate extent of the soils mapped in Grainger County, Tenn.*

Soil	Acres	Percent
Abernathy silt loam	192	0.1
Armuchee silt loam	1,152	.6
Steep phase	5,312	3.0
Very steep phase	2,176	1.2
Armuchee silty clay loam:[1]		
Eroded phase	2,432	1.4
Eroded steep phase	1,856	1.0
Armuchee shaly silty clay loam:[1]		
Severely eroded phase	3,136	1.8
Severely eroded steep phase	3,328	1.9
Atkins fine sandy loam	256	.1
Bolton loam	640	.4
Eroded phase	3,520	2.0
Eroded rolling phase	1,792	1.0
Steep phase	512	.3
Eroded steep phase	1,216	.7
Bolton silty clay loam:[1]		
Severely eroded phase	1,472	.8
Severely eroded steep phase	640	.4
Bruno fine sandy loam	832	.5
Bruno loamy fine sand	320	.2
Clarksville cherty silt loam	384	.2
Hilly phase	1,088	.6
Eroded hilly phase	1,024	.6
Steep phase	2,944	1.6
Eroded steep phase	1,152	.6
Clarksville fine sandy loam:[1]		
Eroded phase	1,472	.8
Eroded hilly phase	896	.5
Clarksville cherty fine sandy loam:[1]		
Eroded phase	1,472	.8
Hilly phase	5,632	3.2
Eroded hilly phase	2,816	1.6
Clarksville cherty clay loam,[1] severely eroded hilly phase	960	.5
Colbert silt loam	64	(2)
Colbert silty loam,[1] eroded rolling phase	320	.2
Cumberland silt loam	64	(2)
Cumberland silty clay loam,[1] eroded sloping phase	128	.1
Decatur silty clay loam:[1]		
Eroded phase	768	.4
Severely eroded phase	448	.3
Eroded undulating phase	384	.2
Eroded hilly phase	192	.1
Severely eroded hilly phase	64	(2)
Dewey silty clay loam:[1]		
Eroded phase	384	.2
Eroded undulating phase	128	.1
Emory silt loam	640	.4
Sloping phase	512	.3
Etowah silt loam	64	(2)
Fullerton silt loam:[1]		
Eroded phase	768	.4
Hilly phase	320	.2
Eroded hilly phase	832	.5
Fullerton cherty silt loam	256	.1
Eroded phase	1,024	.6
Hilly phase	1,920	1.1
Eroded hilly phase	3,584	2.0
Steep phase	2,560	1.4
Eroded steep phase	2,112	1.2
Fullerton cherty silty clay loam:[1]		
Severely eroded hilly phase	448	.3
Severely eroded steep phase	768	.4
Fullerton fine sandy loam	320	.2
Eroded phase	4,608	2.6
Undulating phase	128	.1
Hilly phase	1,024	.6
Severely eroded hilly phase	1,088	.6
Eroded hilly phase	3,968	2.2
Fullerton cherty fine sandy loam	256	.1
Eroded phase	1,792	1.0
Hilly phase	2,304	1.3
Eroded hilly phase	4,032	2.3
Fullerton cherty clay loam:[1]		
Severely eroded phase	320	.2
Severely eroded hilly phase	1,984	1.1
Greendale loam	640	.4
Sloping phase	768	.4
Greendale silty clay loam	128	.1
Sloping phase	128	.1
Guthrie silt loam	64	(2)
Hayter loam	256	.1
Eroded sloping phase	320	.2
Hayter stony loam:[1]		
Eroded phase	256	.1
Hill phase	320	.2
Eroded hill phase	512	.3
Steep phase	256	.1
Eroded steep phase	576	.3
Severely eroded steep phase	448	.3
Hector stony fine sandy loam	192	.1
Hilly stony land:		
Talbott soil material	8,768	4.9
Colbert soil material	2,752	1.5
Holston very fine sandy loam	64	(2)
Eroded sloping phase	128	.1
Huntington silt loam	128	.1
Jefferson stony fine sandy loam:[1]		
Eroded phase	128	.1
Sloping phase	128	.1
Eroded sloping phase	896	.5
Leadvale silt loam	384	.2
Sloping phase	1,024	.6
Lehew stony very fine sandy loam	4,032	2.3
Eroded hilly phase	576	.3
Limestone outcrop	1,664	.9
Lindside silt loam	1,984	1.1
Melvin silt loam	64	(2)
Montevallo shaly silt loam:[1]		
Eroded undulating phase	192	.1
Eroded rolling phase	448	.3
Eroded hilly phase	576	.3
Montevallo shaly silty clay loam:[1]		
Severely eroded rolling phase	256	.1
Severely eroded phase	448	.3
Muskingum very fine sandy loam	10,368	5.8
Eroded phase	1,664	.9
Hilly phase	1,344	.8
Eroded hilly phase	1,984	1.1
Muskingum stony fine sandy loam	2,496	1.4
Hilly phase	1,024	.6
Ooltewah silt loam	320	.2
Philo fine sandy loam	1,664	.9
Pope fine sandy loam	320	.2
Roane silt loam	576	.3
Rollingstony land (Talbott soil material)	4,864	2.7
Rough gullied land:		
Limestone residuum	3,200	1.8
Shale and sandstone residuum	3,328	1.9
Rough stony land:		
Muskingum soil material	8,128	4.5
Talbott soil material	8,640	4.8
Sandstone outcrop	1,664	.9
Sequatchie fine sandy loam	448	.3
Sequoia silty clay loam:[1]		
Eroded phase	2,432	1.4
Eroded undulating phase	448	.3
Sequoia shaly silty clay loam,[1] severely eroded phase	768	.4
Talbott silty clay loam:[1]		
Eroded phase	960	.5
Eroded undulating phase	192	.1
Eroded hilly phase	448	.3
Severely eroded hilly phase	64	(2)
Tyler very fine sandy loam	64	(2)
Waynesboro very fine sandy loam:[1]		
Eroded phase	64	(2)
Eroded sloping phase	192	.1
Eroded hill phase	192	.1
Total	178,560	100.0

[1] Type not mapped.
[2] Less than 0.1 percent.

high-grade limestone. The Decatur, Dewey, Bolton, and the better grade areas of Fullerton soils are the chief source of the material. The surface layer is nearly level or saucerlike. Surface drainage is very slow or lacking, and practically all areas are subject to temporary flooding following periods of heavy precipitation. The permeability of the soil and good subterranean outlets, however, maintain favorable internal drainage for crops. The native vegetation was probably moisture-loving deciduous trees.

This is not an extensive soil, and most of the areas are small and widely scattered in areas containing Fullerton, Bolton, Dewey, and Decatur soils. In general those areas associated with sandy Fullerton and other sandy types have a little coarser texture than those elsewhere.

A profile description is as follows:

0 to 30 inches, brown or dark-brown mellow silt loam, relatively high in organic matter.

30 inches +, lighter brown mottled with gray and yellow silt loam or silty clay loam.

Throughout the entire depth the material is permeable and slightly acid to neutral in reaction. Bedrock limestone is at a depth of several feet.

This type is one of the best soils in the county for agricultural use. It is highly productive, easily worked, presents no serious problems of conservation and, under proper management, is suited to intensive use. Chiefly because of its permeability and position in well-drained depressions, moisture relations are particularly favorable for plant growth. In general the soil is well suited to most crops commonly grown, although small grains may lodge and alfalfa may be severely damaged during extended wet periods.

Practically all this soil has been cleared and is now used intensively for crops. Row crops are commonly grown for many years in succession. About 50 percent of it is used for corn, 20 percent for tobacco, and 30 percent for hay, small grains, and pasture. Fertilizers are not commonly used except for tobacco. Manure and some commercial fertilizer are used for this crop, but applications are relatively light compared with those on less fertile soils. Yields of all crops are relatively high. Corn grown in successive years with little or no fertilization yields 40 to 60 bushels an acre.

Armuchee silt loam.—A light-colored hilly soil of shallow depth to bedrock that affords good grazing but is not suited to cultivation. It is developed from interbedded limestone and shale, most of which is of the Nolichucky geologic formation. The material throughout is moderately to strongly acid. Its hilly surface (12 to 30 percent) is generally a part of a moderately rugged landscape. Internal drainage is retarded but is sufficient for the needs of most plants. The native vegetation was chiefly deciduous hardwoods, as oaks and hickory, with some pine intermixed.

This is the least extensive of the Armuchee soils and is associated chiefly with the other soils of this type.

A profile description is as follows:

0 to 1 inch, dark-gray silt loam.

1 to 6 inches, yellowish-gray friable silt loam.

6 to 20 inches, reddish-yellow moderately tough and plastic silty clay that is permeable to roots but slowly permeable to water.
20 inches +, mottled red and yellow, gray, and brown moderately tough and plastic silty clay containing a large quantity of soft shale fragments. Bedrock shale or limestone is at a depth of about 30 inches.

The variations in the soil relate to the hilly nature of the landscape and to differences in the bedrock. In some places, the shale may be within 10 inches of the surface and limestone beds commonly outcrop. The color of the subsoil varies from yellowish red to brownish yellow and in places where the underlying rock is limestone, the thickness of the soil over the rock is greater and the subsoil may be more plastic.

This soil is not well suited to crops requiring tillage,[6] chiefly because it is difficult to conserve against serious losses by erosion when in a tilled condition. Because of the strong slope and shallow depth to the heavy less friable subsoil its workability is rather difficult. It is at least moderately fertile and is capable of affording good grazing when cleared and allowed to develop a grass cover.

Practically all the soil is forested. Areas that are cleared for pasture generally establish a good volunteer stand of bluegrass and white clover, and, if kept clear of weedy and brushy growth, make good pasture. If crops must be grown, those that will maintain a close-growing cover as much of the time as possible should be used. A rotation consisting of fall-sown small grains, hay, and pasture is most suitable, although it may be expedient to grow a row crop occasionally, particularly the first year after the pasture sod is turned under. Although moderately good pastures are maintained with but little effort, an appreciable response may be expected from applications of phosphorus.

Armuchee silt loam, steep phase.—This soil differs from the silt loam in having a steeper slope (30 to 60 percent). The thickness of the soil over bedrock is a little less, and rock outcrops are more common. A small quantity of this soil is developed on steep slopes overlying clayey or argillaceous limestone in association with Talbott soils. This is the most extensive of the Armuchee soils, and is widely distributed throughout the area occupied by this type.

To a depth of 3 to 5 inches the surface layer is grayish-brown silt loam. Below this is yellowish-red somewhat mottled with gray plastic silty clay. Bedrock limestone or shale is at a depth of as much as about 3 feet, and there are a few rock outcrops.

The soil is suitable for permanent pasture, but is very poorly suited to crops requiring tillage, chiefly because of its steep slope, shallow depth to bedrock, and susceptibility to erosion.

Practically all this soil is in forest, consisting chiefly of oak, hickory, and some pine. If properly managed it affords good grazing, but great care must be taken to maintain a good protective cover against erosion. Cleared but not tilled areas generally establish a good volunteer bluegrass and white clover cover providing brushy and weedy growth are

[6] The term "crops that require tillage" refers to those crops, including hay, that require the use of tillage implements either in the preparation of the seedbed or for cultivation during the growing period.

kept suppressed and material losses of surface soil are not allowed to take place.

Armuchee silt loam, very steep phase.—This soil differs from the silt loam in having a much steeper slope (60 to 85 percent) and a shallower more uneven depth to bedrock. An extensive variation consists of purplish-red shaly silty clay underlain by purplish-red calcareous shale and sandstone of the Sequatchie geologic formation.

This type is less extensive than some of the other Armuchee soils. Practically all of it is on the upper part of the northwest slope of Clinch Mountain. The purplish-red variation is in this belt and lies directly below the mountain crest.

This soil is not suited to either crops requiring tillage or pasture, chiefly because of its very steep slope and shallow depth to bedrock. Except a very small part, all of it is in forest. This cleared part is used chiefly for corn and pasture. Crop yields are low and soil losses by erosion are severe. Forest is the use to which this soil is best suited. Deciduous hardwoods, including locust and walnut, predominate in the virgin forest.

Some of the areas that have been cleared and cropped are severely eroded, but their aggregate area is too limited to justify separating them on the map.

Armuchee silty clay loam, eroded phase.—As a result of erosion this soil consists of areas of the silt loam that have lost 50 to 75 percent of the surface soil. In general, it represents areas that have been tilled but not severely eroded. Occasional small areas are included that are not eroded materially, and a few small outcrops of limestone are on some of the northwest-facing slopes. The relief is hilly (12 to 30 percent). Internal drainage is sufficient for all plants grown but owing to slow percolation and strong slope, the volume of runoff is relatively large.

The surface layer consists of a mixture of surface and subsoil materials, which in places consists almost entirely of subsoil material. A large part of the 4- to 6-inch layer is yellowish-gray silty clay loam. Beneath the surface layer the material is similar to that of the subsoil and substrata of the silt loam.

This is not an extensive soil, although its aggregate area is greater than that of the silt loam. It is associated with other Armuchee soils and stony land types.

This phase is not well suited to crops requiring tillage. Its workability is difficult chiefly because of the strong slope and shallow depth in places to the heavy subsoil material or bedrock, and it is difficult to conserve against losses by erosion and to maintain the productivity under a system of continuous cultivation.

All this soil has been cleared, but about 15 percent of it is idle and occupied chiefly by a brushy cover of briers, second-growth saplings, redbud, and other growth of low value. Nearly half of its total area is used as pasture. Bluegrass and white clover, the predominant plants, afford good grazing. Between 30 and 40 percent of it is used for corn, small grains, and hay, and yields are 15 to 20 percent lower than those obtained on Sequoia silty clay loam, eroded phase. Most cropped areas are not used in a consistent rotation. They may be cropped for several

years and then allowed to be idle or used as pasture for some time. Fertilization is not practiced regularly, and very little barnyard manure is used. Pasture can be expected to respond well to applications of phosphorus, fertilizer, and lime. If circumstances make it necessary to grow crops, a rotation should be used consisting chiefly of close-growing fall-sown small grains and hay so as to maintain a protective vegetative cover on the soil as much of the time as possible.

Armuchee silty clay loam, eroded steep phase.—As a result of erosion this phase differs from Armuchee silt loam in having a steeper slope and in having lost approximately 50 to 75 percent of the surface soil. The surface has a slope of 30 to 50 percent, and the depth to the underlying bedrock is more variable, and in general, shallower. There is a small variation associated with Talbott soils. These areas have a reddish-yellow moderately mottled with gray plastic silty clay subsoil underlain at a shallow depth by limestone.

This is one of the less extensive of the Armuchee soils. It represents those areas of Armuchee silty clay loam, steep phase, that have been cultivated and materially eroded. The areas are widely distributed in association with other Armuchee soils.

The soil is not well suited to crops requiring tillage. Its steep slope makes it difficult to work, and this together with the slow rate of moisture absorption and shallow depth to bedrock, makes it very susceptible to injury by erosion. It is best suited to pasture.

All this soil has been cleared, but now about 30 percent is abandoned to brush or forest growth. Most of the remaining part is used for pasture and hay. Lespedeza is the chief hay crop. Corn is grown on a small part. Yields are small and the quality and carrying capacity of the pasture is variable, depending chiefly on the quantity of soil lost by erosion and the direction or exposure of the slope. In general, pasture on the more northern-facing slopes is better than that on the more southern-facing slopes. Pasture vegetation responds well, especially to phosphorus, and under good management, including particularly applications of phosphorus and suppression of weedy and bushy growth, a fair to good cover of bluegrass and white clover can be maintained.

Armuchee shaly silty clay loam, severely eroded phase.—As a result of erosion this soil consists of areas of Armuchee silt loam that have lost practically all the original surface soil and in places part of the subsoil. In general, it represents areas of Armuchee silt loam that have been cleared and severely eroded. Most areas have some gullies, many of which, though crossable by machinery, are not obliterated by tillage. Occasional gullies, 2 to 4 feet deep, do not prohibit field operations. Occasional small outcrops of limestone are on some of the northwest-facing slopes, and very shaly patches are common on the southeast-facing slopes. A large part of this soil is on southeast-facing slopes, and is, therefore, more shaly than the less eroded Armuchee soils. The relief is hilly (12 to 30 percent). Percolation of moisture is very slow and consequently much of the rainfall is lost as runoff. This is one of the more extensive of the Armuchee soils and is associated with other soils of this type.

The grayish-yellow or reddish-yellow shaly silty clay loam surface layer consists chiefly of subsoil material. Below this layer is the

reddish-yellow moderately tough and plastic shaly silty clay of the normal Armuchee subsoil.

This phase is not well suited to tillage, and most areas cannot be expected to support much grazing. In general the soil is low in fertility, droughty, and runoff is difficult to control. Most areas probably should be planted in or allowed to revert to forest.

All this soil has been cleared and cropped, but about 60 percent of it has reverted to forest, lies idle, or is used as unimproved pasture. Corn, small grains, and hay are grown on the rest, but yields are low. Little fertilization is practiced and management in general is at a low level. Most of the pasture is of only fair quality. Broomsedge and other plants of low grazing value predominate. Pasture responds to lime and fertilizer, especially phosphorus, but the carrying capacity in general does not equal that of the less eroded Armuchee soils.

Armuchee shaly silty clay loam, severely eroded steep phase.—This soil differs from Armuchee silt loam in having a stronger slope and in having lost practically all of its surface soil and, in places, part of its subsoil by erosion. Gullies, though not numerous, are common. The slope ranges from 30 to 60 percent with the result that runoff is very rapid. Because of its steep slope and severely eroded condition, this soil is not suited to crops, and its droughty nature and low state of fertility cause it to be very poorly suited to pasture. This is one of the more extensive Armuchee soils, with which it is associated.

The surface material varies considerably depending chiefly on the quantity of erosion that has taken place. In most places the material is grayish-yellow or reddish-yellow shaly silty clay loam or clay underlain by bedrock shale or limestone at a depth of a few inches to 20.

All this soil has been cleared and used for crops at some time, but nearly half of it is now covered by reestablished forest or brush. A very small part is cropped chiefly to corn, and the rest is in pasture. The quality of the pasture is poor, and its carrying capacity is low. As it is difficult to establish and maintain a pasture cover on this soil, its best use is for forest.

A very limited variation representing severely eroded steep areas of Talbott soils is included with this Armuchee soil.

Atkins fine sandy loam.—A poorly drained soil of the first bottoms associated with Muskingum and other soils developed chiefly from acid sandstone materials. The surface is nearly level, and practically all areas are subject to flooding. The few exceptionally wet areas are indicated on the map by wet-spot or marsh symbols. The natural vegetation is chiefly moisture-loving deciduous trees, of which oak, beech, poplar, sycamore, maple, willow, and alder are predominant species.

The aggregate area is small, and most of it lies as narrow strips associated with Philo and Pope soils along the small creeks of Poor Valley and Poor Valley Ridge.

A profile description is as follows:

0 to 7 inches, gray mottled with yellow and brown friable fine sandy loam.

7 to 30 inches, gray mottled with yellow and brown firm but friable fine sandy clay loam.

The material of this lower layer is variable in texture. In places, it

is more sandy throughout its entire depth and some parts consist of laminations or layers that vary greatly from each other in texture. All layers are medium to strongly acid and low in organic matter. The material is permeable to roots, but their development is limited throughout much of the growing season by the high water table.

This type is not well suited to crops requiring tillage, but most areas are fairly well suited to pasture. Areas properly drained artificially are suited to crops, as corn and certain hay crops, but the feasibility of such improvement depends on several other factors besides the soil.

About 70 percent of this soil is cleared, and most of this is used for hay and pasture. Moisture relations are favorable for these crops, but the quality of the vegetation is generally poorer than that on better drained more fertile soils. Redtop, sedges, and other lowland plants predominate on most areas used for hay and pasture. Except on the wettest parts, considerable improvement in the quality and quantity of hay and pasture can be expected from applications of fertilizer, especially lime and phosphorus. Where such treatment is practiced, bluegrass and white clover tend to come in. Corn yields on those areas now used for this crop average only fair, and during exceptionally wet seasons they are very low.

Bolton loam.—A brownish-red soil commonly associated with soils of the Fullerton series, developed over dolomitic limestone and lying in a predominantly rolling to hilly landscape. The relief is hilly (12 to 30 percent), and internal drainage is good. Native vegetation was predominantly oak, hickory, chestnut, yellow-poplar, and maple. All of this has been cut-over with the result that in many areas other less useful species are now intermixed. All chestnut is now either dead or has been cut-out.

This is one of the least extensive of the Bolton soils. Most of it is in the south-central part of the county and on Copper Ridge.

A profile description of a sample in a cultivated area is as follows:

0 to 10 inches, brown to light reddish-brown very friable silt loam. The material has a fluffy, slightly spongy feel.

10 to 50 inches, brownish-red or red friable silty clay. Small dark-brown concretions are common in this layer.

50 inches +, yellowish-red mottled or splotched with gray and dark-red firm but friable silty clay. Bedrock dolomitic limestone is at a depth of 25 to 30 feet.

The soil is medium to strongly acid throughout and is permeable to roots and water. In most places there are a few small chert fragments throughout the soil mass, and sandstonelike fragments are common on those areas associated with the sandy Fullerton and sandy Clarksville soils. In some places the surface soil is lighter colored and has a somewhat less fluffy feel in the surface layer.

Fairly well suited to crops and to pasture, the fertility of this soil is moderately high and the soil is productive of most crops commonly grown. Its hilly surface makes its workability somewhat difficult and contributes to making it subject to severe damage by runoff when not properly managed. Its tilth is not so good as that of the Dewey and Fullerton silt loams inasmuch as tillage implements will not scour well, particularly in the areas having a more fluffy or spongy surface soil.

Practically all this soil is in forest. Corn, small grains, and most hay crops are suited to it, but row crops should not be grown frequently. Moderately long rotations consisting chiefly of fall-sown small grains, hay, and pasture are suitable providing the soil is maintained in a sufficiently productive state to support a good vegetative cover. Lime and phosphorus are the chief fertilizers needed and are particularly required if good yields of red clover and alfalfa are to be obtained. Other plant nutrients, however, must be replenished also under a system of continuous cropping. Owing to the erosion hazard on the slopes, tillage and planting should be on the contour and strip cropping and terracing may be advantageous under some conditions. Under a relatively high level of management, corn can be expected to yield 30 to 35 bushels, wheat 15 to 20 bushels, and lespedeza 1¼ to 1½ tons of hay an acre.

Water control is an important part of a good system of management, and adequate fertilization with long rotations that keep a good close-growing cover on this soil most of the time contribute much to this accomplishment. Contour tillage should be practiced as much as possible, and under some circumstances strip cropping and terracing may be beneficial.

A few areas of Dewey silt loam, hilly phase, are included with this type because of its limited area and similarity.

Bolton loam, eroded phase.—As a result of erosion this soil differs from the type in having lost 50 to 75 percent of the surface soil. Over much of the area the plow layer consists of a mixture of surface and subsoil materials, and in some places it consists almost wholly of subsoil material. Much of the 4- to 6-inch surface layer is reddish-brown silty clay loam. Below this is brownish-red firm but permeable silty clay similar to that of the subsoil of the type.

This is the most extensive of the Bolton soils. Most of the areas range from 5 to 40 acres in size and are intermingled chiefly with Fullerton and other Bolton soils.

The soil is fairly well suited to crops and pasture. It is moderately productive, but its strong slope makes it difficult to work and to conserve properly against losses by runoff. Its tilth is somewhat less favorable than that of Dewey and Fullerton silt loams, due to the partial incorporation of heavy subsoil material in the plow layer and to the failure of the more fluffy or spongy areas to scour well when tilled.

All this soil has been cleared and cultivated. About 30 percent is used for corn and small grains, 40 percent for hay and pasture, 20 percent is idle or unimproved pasture, and about 10 percent is abandoned at least temporarily. No very systematic rotation is followed, and fertilizer when used is applied chiefly for row crops, although some is used for small grains. Some lime and phosphate have been applied for both crops and pasture and favorable results are common. Under average conditions corn yields about 20 bushels, wheat 8 to 12 bushels, and lespedeza ½ to 1 ton an acre. Most pasture consists of a variable mixture of plants, chief of which are redtop, lespedeza, and broomsedge, with other less palatable grasses intermixed. The carrying capacity of such pasture is moderate.

Good management requires fairly long rotations of fall-sown small grains, hay, and pasture crops. Red clover, alfalfa, and timothy are suited to this soil, but the legumes require at least lime and phosphorus

in order to produce well. Moderate applications of practically all plant nutrients are necessary if the productivity for all crops is to be maintained at a high level. Both the quality and carrying capacity of pasture may be improved under proper fertilization, which includes especially lime and phosphorus. Applications of 2 to 3 tons of lime an acre are generally sufficient if made at intervals of 4 to 6 years. Small areas of Dewey silty clay loam, eroded hilly phase, are included with this soil.

Bolton loam, eroded rolling phase.—As a result of erosion this soil differs from the type in having a less sloping surface that has lost 50 to 75 percent of its surface. The surface is undulating to rolling, the gradient seldom exceeding 12 percent. Internal drainage is good, and roots penetrate the soil easily. Most areas are on ridge tops associated with other Bolton soils.

This soil includes a small acreage that has not been materially eroded and most of it is still in forest. There are also very small areas that have been severely eroded and here the plow layer consists almost wholly of brownish-red or red firm silty clay.

Well suited to crops and pasture, this soil is moderately fertile, is not difficult to conserve, and is easily worked except that some difficulty is experienced in getting tillage implements to scour well.

All except a small part of this soil is cleared and is used either for crops or for pasture. Approximately 40 percent is used for corn, 40 percent for hay and rotation pasture, and most of the rest for small grains. Although the acreage is relatively small, tobacco is an important crop. Crops are rotated some, but row crops are not uncommonly grown several years in succession. Manure and commercial fertilizer are applied in fairly heavy applications for tobacco, but other crops receive little manure and irregular and light applications of other fertilizer. Cover crops are grown occasionally by some farmers to be turned under, and lime has been applied to a large part of the acreage. Yields under average conditions are as follows: Corn, 25 to 30 bushels; wheat, 10 to 15 bushels; and timothy and clover hay, ¾ to 1½ tons an acre.

Good management includes particularly the use of a 3- or 4-year rotation in which are legume hay or pasture crops and cover crops and adequate fertilization, including especially phosphorus and lime, and adequate protection against the hazards of runoff water especially on the more sloping parts. Good pasture especially requires lime and phosphorus and the eradication of weeds and brushy growth.

Bolton loam, steep phase.—This phase differs from the type in having a stronger slope (25 to 40 percent), a little greater chert content, and less depth to bedrock. Most of the small aggregate area is in the southern part of the county.

Chiefly because of its steep slope, this soil is poorly suited to crops requiring tillage but is well suited to pasture. Tillage of these areas involves considerable effort and much risk of damage by erosion.

All this soil is in forest consisting chiefly of oak, hickory, yellow-poplar, and maple, with some pine intermixed. Good permanent pasture may be maintained where grass and clover is established directly following the clearing of the land.

A very small quantity of Dewey silt loam, steep phase, is included

with this soil, and these areas are associated with the Dewey soils.

Bolton loam, eroded steep phase.—As a result of erosion this soil differs from the type in having a steeper slope and in having lost 50 to 75 percent of its surface soil. The chert content is a little higher, and the depth to bedrock is shallower and more variable. This phase is commonly associated with Bolton, Fullerton, and Clarksville soils north and east of Perrin Hollow School.

Because of its steep slope and limited productivity, this soil is poorly suited to crops requiring tillage. It is suited to pasture but is subject to damage by runoff even in this use, if a good vegetative cover is not maintained.

All this soil has been cleared but about 25 percent has reverted to forest or is idle. About 15 percent is used for corn, 50 percent for hay and pasture, and 10 percent for small grains and other crops. Yields are lower and soil losses by erosion are greater than on the type. Pasture is generally of fair quality and is much improved by proper fertilization. Lime and phosphorus are the chief fertilizer elements needed to improve pasture. Generally some special effort is required to keep weedy and brushy growth suppressed.

A small quantity of Dewey silty clay loam, eroded steep phase, and a small quantity of purplish variation developed over material weathered from the rock of the Tellico formation is included in this soil.

Bolton silty clay loam, severely eroded phase.—This soil differs from the loam type in having lost practically all of the surface soil and in places part of the subsoil as a result of erosion. Small gullies are common though not sufficiently abundant to prohibit tillage. The surface is hilly, the gradient ranging from 12 to 30 percent. The plow layer is predominantly brownish-red firm but moderately permeable silty clay. Percolation is retarded and runoff develops quickly during periods of precipitation.

The small aggregate area of this soil is widely distributed in association with Fullerton, Clarksville, and other Bolton soils.

This soil is poorly suited to crops requiring tillage, but under good management is well suited to pasture. The productivity is low and the soil is difficult to work and conserve. Because of the slow percolation of water and the strong slope, runoff is hard to control.

All this soil has been cleared and cropped but about 30 percent has been abandoned and is now occupied either by a reestablished forest cover or a brushy growth of sassafras, persimmon, and broomsedge. About 25 percent is used for corn, 10 percent for small grain, and the rest for hay and pasture. Yields of all crops are low, and hay and pasture are of fair to poor quality. Row crops are grown more frequently than the physical condition of this soil warrants and inadequate fertilization is the general rule.

When possible this soil should be used for permanent pasture. With proper fertilization and control of weedy and shrubby growth pasture should arrest further serious losses of soil material by erosion and after a few years develop a cover of fair to good quality grazing vegetation. When the fertility has been sufficiently recovered, bluegrass and white clover can be expected to comprise a considerable part of the pasture sod.

Bolton silty clay loam, severely eroded steep phase.—This phase has a steeper slope than Bolton loam, and has lost practically all the surface soil and in places part of the subsoil by erosion. The gradient ranges from 25 to 45 percent. Small gullies are common but are not sufficiently large or abundant to prohibit tillage.

It is poorly suited to crops and pasture. Its productivity is low; it is difficult to work; and when tilled it is practically impossible to prevent serious loss by runoff.

All this soil has been cleared and cropped, but more than 50 percent of it is now abandoned to forest or lies idle. The greater part of the rest is used for pasture or hay. Most of the hay is lespedeza, and the pasture is chiefly lespedeza and redtop with variable quantities of broomsedge and brushy growth intermixed. Hay and pasture yields are low. Most areas probably can be best used for forest, although with proper fertilization the most favorably located areas, as on some of the north-facing slopes, may be improved to where they afford good pasture.

Bruno fine sandy loam.—Occurs on the first bottoms along the Holston River and consists of sandy alluvium deposited by the river, the material of which was derived chiefly from sandstone and shale with some from limestone intermixed. The surface is nearly level to gently undulating, and internal drainage is good except as interfered with by flooding. In general, the soil occupies the higher parts of the bottoms. About half of the aggregate area was inundated by the Cherokee Reservoir. The areas now in the county are along the Holston River downstream from the reservoir, and a few along the Clinch River above the upper limit of Norris Reservoir in the northern part. Most areas are associated with the loamy fine sand and with Huntington silt loam. The native vegetation was moisture-tolerant deciduous hardwoods.

A profile description is as follows:

0 to 15 inches, light-brown or light yellowish-brown fine sandy loam.

15 inches +, lighter brown friable material that is generally finer textured loam or friable sandy clay loam.

In places the subsoil grades into coarser rather than finer textured material and these areas approach the loamy fine sand type in their textural nature. Bedrock lies at a considerable depth.

This soil is slightly acid, its content of the chief plant nutrients is moderate, and the quantity of organic matter is rather low. It is easily permeable to roots and moisture, and its ability to hold moisture available to plants is fairly good. The most sandy areas are droughty. The water table is at a depth of 8 to 10 feet in most areas. All areas are subject to overflow, but the frequency and extent of overflow have been reduced by the establishment of the Cherokee Reservoir.

This type is good to very good cropland and good pasture land. Its productivity is good, it responds well to fertilization, and it is easily worked and conserved. It is particularly well suited to corn and the many truck crops that require an open, easily cultivated seedbed.

Practically all this soil has been cleared and is now used for crops or pasture. About 60 percent is used for corn, about 25 percent for hay and pasture, and most of the rest for small grains and truck crops.

Short rotations and, on some fields, long sequences of corn year after year are used. Some mixed fertilizer is used on corn and small grains, but only a small quantity of barnyard manure is used, and very few green-manure crops are grown. Under average conditions, corn yields about 32 bushels, lespedeza about 1.1 tons, and wheat about 15 bushels an acre.

Increased fertilization, organic matter, and somewhat longer rotations can be expected to increase yield appreciably. Inasmuch as this soil is more sandy and less acid than most of the upland soils, the lime requirement is less. Nitrogen, phosphorus, and potassium are all needed in order to maintain a high productivity under a system of moderately intensive use. Red clover, alfalfa, white clover, and other legumes produce well where the fertility is brought to a moderately high level. Good pasture can be established, although the carrying capacity and quality hardly equal that of well-managed pastures on soils as Lindside silt loam and Hayter loam. Under a high level of management, corn yields about 45 bushels, barley about 28, and red clover about 2 tons an acre.

Bruno loamy fine sand.—The most sandy soil of the first bottoms along the Holston River, derived from sandstone with some material from limestone and shale intermixed. The surface is undulating or gently billowy with a strongly sloping escarpment adjacent to the river channel. Internal drainage is very rapid or, from the standpoint of agricultural needs, excessive.

Probably half the area was covered by the impounded water of the Cherokee Reservoir. Practically all the acreage now in the county is along the Holston River below Cherokee Dam. Almost all the areas either lie as natural levee strips adjacent to the river channel or on low islands. Where they occur as natural levees, they are a little higher than the other adjoining soils of the first bottoms. All areas are subject to overflow but the frequency and extent have been reduced since the establishment of Cherokee Reservoir.

A profile description is as follows:

0 to 20 inches, light-brown or light yellowish-brown loamy fine sand.

20 inches +, lighter colored fine sand. Bedrock is at a considerable depth.

This soil is moderately acid and low in plant nutrient and organic matter. It is open or very permeable and infiltration is very rapid, very little, if any, runoff developing during rains. Its capacity for holding moisture available to plants is small, and consequently it is a droughty soil for shallow-rooted crops. On those areas where the water table is not at too great a depth, the deep-rooted crops are much less subject to drought.

This is a fair soil for crops and a poor soil for pasture. Its moisture relations are relatively unfavorable for many crops and pasture plants and it is difficult to develop and maintain a high productivity. Deep-rooted plants, as corn, sorghum, sericea lespedeza, and melons are probably among the better suited crops.

A large part of the soil is used for crops and pasture. About 50 percent is used for corn and truck crops, about 25 percent for hay and

pasture, and the rest for small grains. Yields of all crops are ordinarily low. Light applications of fertilizer are used for corn and wheat, and a small quantity of manure is applied to some areas. Where heavy fertilization is practiced and showers persist during the growing period or irrigation is practiced, good yields can be expected. The more favorable areas are well suited to certain truck crops, as melons, where ample plant nutrients and moisture are supplied. In general pastures are not of good quality, and the grazing period is generally short because of the unfavorable moisture conditions.

Clarksville cherty silt loam.—Most of the areas are on rounded ridge crests associated with Fullerton and other soils of the Clarksville series. The soil is developed over cherty dolomitic limestone. Practically all the areas are in the vicinity of Hinds and Copper Ridges. This is the least extensive of the Clarksville soils.

The surface is undulating to rolling, and internal drainage is good. Although some drainage is by way of surface drainways to permanent streams, a notable part is to sinkholes most of which have adequate underground outlets. The native vegetation was principally deciduous hardwoods, as oak, hickory, sourwood, and yellow-poplar.

More than half of the acreage has lost 50 to 75 percent of its surface soil as a result of erosion. The remaining acreage is virtually uneroded. The following description is of that part not materially eroded:

0 to 14 inches, light-gray friable cherty silt loam.
14 to 32 inches, yellow firm friable cherty silty clay loam.
32 inches +, reddish-yellow or yellow splotched with red, gray, and brown firm but friable cherty silty clay loam. Bedrock cherty dolomitic limestone is at 20 to 40 feet below the subsoil.

Chert fragments from less than an inch to 6 inches in diameter are throughout the soil mass, and in places they are so abundant as to practically prohibit tillage operations. The organic-matter content is very low, and the reaction throughout the entire soil is medium to strongly acid. The water-holding capacity is fair to good, and the soil mass is permeable to plant roots and moisture.

The areas that have been materially eroded have a 4- to 6-inch surface layer of grayish-yellow cherty silt loam below which is yellow cherty silty clay loam subsoil. There are a few spots where yellow subsoil material is exposed. In general, chert is much more abundant on the surface of the eroded areas.

This soil is fair as cropland and pasture. Its low natural fertility causes very low crop yields and pasture of poor quality unless comparatively heavy fertilization is practiced. If properly managed, it is well suited to corn, tobacco, potatoes, sweetpotatoes, oats, rye, redtop, lespedeza, and soybeans. With ample fertilization, including manure and lime, red clover yields are satisfactory. Peaches, grapes, and raspberries can be expected to yield well if given proper care and adequate fertilization.

About 25 percent of the soil is under forest, about 20 percent is used for row crops, principally corn, 25 percent for hay and pasture, 20 percent for small grain, and 10 percent is idle. Tobacco is the chief cash crop. Under present management the average acre yields are about

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15 bushels of corn, 8 bushels of wheat, 700 pounds of tobacco, and 1/2 to 3/4 ton of hay. Most of the pastures are of poor quality and consist chiefly of broomsedge except where they are well managed. Lespedeza is the main hay crop. Korean lespedeza following row crops that had been treated with light applications of mixed fertilizer yielded 0.9 ton of hay. On a field of this type in an adjoining county, tobacco treated with moderate application of manure and 650 pounds of mixed fertilizer yielded 1,200 pounds an acre, and potatoes with a fairly heavy application of manure yielded 80 bushels.

The management differs somewhat from place to place. The most common rotation used is: Corn, 1 year; small grain, 1 year; and lespedeza or lespedeza and grass, 1 or 2 years. Some fertilizer is generally some evidence that immediate response to fertilization is greater than years of cropping, it is a common practice to allow this soil to be idle for 2 to 5 years. Mechanical means for water control, as terracing are not generally practiced.

The response of this soil to good management is notable. There is used for these crops but the kind and quantity differ. After several that for the Dewey soils but that the beneficial effects are not so lasting. This indicates that in a good management procedure, applications of amendments should be lighter but more frequent than on soils as those of the Dewey series. As the Clarksville soils are low in lime and phosphorus, the frequent replenishment of these constituents should be one of the major parts of a good system of management; in fact, if legumes as red clover and alfalfa are to be grown, it is essential that both be applied. One field of Kansas common alfalfa on an area outside the county that had lain idle for 2 years and then fertilized with 250 pounds of 43-percent triple superphosphate, 2½ tons of lime, and a moderate application of manure yielded 2.5 tons of hay an acre the first year. The second year the equivalent of 150 pounds of triple superphosphate was applied and the yield during a dry season from four cuttings was 2 tons. Organic matter is also essential to the maintenance of a relatively high productivity, and for this purpose the turning under of legume or small-grain cover crops is beneficial where manure is not available. Pastures of good quality are more difficult to maintain than on the more fertile soils. Both lime and phosphorus are required if the more palatable pasture mixtures are to be maintained.

Clarksville cherty silt loam, hilly phase.—One of the less extensive of the Clarksville soils. Areas of it are associated with other phases of the type and all are associated with areas of the Fullerton, Clarksville, and Bolton soils. The hilly surface, chertiness, and low fertility are largely responsible for its poor suitability for crops and only fair suitability for pasture. If it is to be tilled, rotations consisting chiefly or wholly of close-growing crops should be used.

The 8- to 10-inch surface layer is gray cherty silt loam below which is yellow cherty silty clay loam subsoil. This phase differs from the type in having a more hilly surface (12 to 30 percent) and in not having lost an appreciable part of the surface soil by erosion. The depth to bedrock is more variable and in general a little less than that of the type, and chert is somewhat more abundant.

Forest, consisting of oak, hickory, sourwood, and yellow-poplar with some pine, covers all this soil. Cleared areas will afford fair pasture,

but good quality grazing will require substantial applications of lime and phosphorus. If conditions make it necessary to use this soil for crops, a rotation should be used that will keep the soil covered by a sod or close-growing crop as much of the time as possible. A good rotation consists of fall-sown small grains and lespedeza with very infrequent row crops. Good yields will require moderate but frequent applications of fertilizer and lime.

Included with this soil are small areas of Fullerton cherty silt loam, hilly phase, too small to be represented separately on the map.

Clarksville cherty silt loam, eroded hilly phase.—One of the less extensive of the Clarksville soils, this soil is associated chiefly with other Clarksville soils in the Hinds Ridge and Copper Ridge sections.

The 4- to 6-inch surface layer is grayish-yellow cherty silt loam with a few spots in which the subsoil is exposed. Below this layer is the yellow firm but friable cherty silty clay loam subsoil. This soil differs from the eroded areas of the type chiefly in having a hilly rather than rolling surface (12 to 30 percent). Its hilly surface, chertiness, and low fertility are largely responsible for its poor suitability for crops and fair suitability for pasture. Areas to be tilled are suited to rotations consisting of close-growing crops and pasture.

All this soil has been cleared and cropped but about a fourth of it has been abandoned to forest or unimproved pasture. About 20 percent of it is used for corn, 40 percent for hay and improved pasture, and 15 percent for small grains, chiefly oats and rye, and other crops. Average yields are low. Due to the difficulty of controlling runoff, close-growing crops should be grown and the surface kept under a growing vegetation as much of the time as possible. For this purpose, fall-sown small grains, lespedeza, redtop, and other biennial and perennial legume and grass hay and pasture crops are well suited. Where conditions permit, this soil is best used as permanent pasture. The quality of pasture vegetation will improve greatly where ample applications of lime and phosphorus are made.

Included with this soil are a few areas of Fullerton cherty silt loam, eroded hilly phase, too small to show separately on the map.

Clarksville cherty silt loam, steep phase.—This phase differs from the type chiefly in having a steeply sloping surface and a more variable thickness of the soil layers and depth to bedrock. The surface is steep, the gradient ranging from 30 to more than 50 percent. The soil is developed over cherty dolomitic limestone and has good internal drainage. Surface drainage is chiefly through drainways and creeks, although a small quantity is to sinkholes that generally have adequate underground outlets. The native vegetation was chiefly oak, hickory, sourwood, and yellow-poplar.

This is one of the more extensive Clarksville soils. Most of it is associated with the Fullerton, Clarksville, and Bolton soils, principally in the northwestern part of the county.

A profile description is as follows:

0 to 12 inches, light-gray friable cherty silt loam.
12 to 20 inches, yellow firm but friable cherty silty clay loam.
20 inches +, reddish-yellow or yellow splotched with red, gray, and brown firm but friable cherty silty clay loam.

A great part of this soil is much more cherty than that of the type, and the depth to bedrock is more variable and in general shallower. The entire profile is medium to strongly acid.

Because of its steep slope and low fertility, this soil is poorly suited to crops and only fairly to poorly suited to pasture. Its best use is for forest, which consists of oak, hickory, sourwood, and yellow-poplar, with some yellow pine. When cleared, areas afford some pasture but the carrying capacity is low unless substantial quantities of phosphorus and lime are applied.

A few areas of Clarksville cherty fine sandy loam, steep phase, are included with this soil.

Clarksville cherty silt loam, eroded steep phase.—This soil differs from the type in having a steep slope and in having lost 50 to 75 percent of the surface layer by erosion. The layers and depth to bedrock are more variable and the chert content is greater. Included with this soil is a small severely eroded acreage from which all the surface soil and in places part of the subsoil have been lost as a result of erosion. The areas of this soil are not large and are thinly distributed throughout areas of Fullerton, Clarksville, and Bolton soils.

The soil is very poorly suited to crops and only fairly to poorly suited to pasture. All this soil has been cleared and tilled, but a great part is now used either as unimproved pasture or has been allowed to revert to a brushy or forest growth. Only a very small part is cropped. Unimproved pasture is of poor or fair quality and the carrying capacity is low. Good pasture requires at least substantial applications of lime and phosphorus and the suppression of weedy and brushy growth. Stands of bluegrass and white clover are not easily maintained, but lespedeza and redtop are relatively well suited to it. Its best use is for forest.

Clarksville fine sandy loam, eroded phase.—This soil differs from the cherty silt loam in having a notable quantity of sand throughout its profile. It is developed from arenaceous or sandy dolomitic limestone of the Knox dolomite formation. The surface is undulating to rolling, and most of the areas are on rounded ridge tops. Internal drainage is good. The native vegetation was mostly deciduous hardwoods, chiefly oak, hickory, sourwood, and yellow-poplar.

Almost all the aggregate area is in the area south of Richland Knobs. This soil is medium to strongly acid throughout its entire depth.

A profile description is as follows:

0 to 6 inches, light-gray fine sandy loam.

6 to 30 inches, yellow (in places reddish-yellow when moist) moderately firm but friable fine sandy clay loam containing some chert.

30 inches +, reddish-yellow or yellowish-red splotched with red and gray firm but crumbly fine sandy clay containing some chert. Sandy dolomitic limestone bedrock is at a depth of 20 to 40 feet.

The thickness of the surface layer varies greatly. The very limited acreage that has never been tilled has a surface layer 10 to 14 inches thick, and in these areas the surface inch or two is dark gray, due to the relatively high content of organic matter. On the other hand there

are patches where nearly all or all of the surface soil has been lost by erosion and the heavier yellow subsoil is exposed. A few small areas have some chert, but these are too small to have been delineated as areas of the cherty phase. The organic matter of the upper 2 inches of the virgin areas is not very permanent and consequently disappears within a short time after cultivation. The permeability of this soil is good and the moisture-holding capacity is moderate. Its natural fertility is very low.

This soil is fair as cropland. It is easily worked and the control of runoff is not difficult; but its natural fertility is low and at least under average management, rather difficult to maintain at a high level of production. It is only fair pasture land, the quality of the vegetation being rather poor unless heavy applications of fertilizer are made. It is physically suited to row crops, as corn, and sorghums for forage, certain small grains, and lespedeza and redtop. It is suited to more exacting crops only if substantial applications of fertilizer are made regularly.

Practically all this soil is cleared and most of it is cropped or used for pasture. About 25 percent is used for corn, 30 percent for hay and temporary pasture, 25 percent for small grains, chiefly wheat, a small part for tobacco and truck crops, and about 15 percent is idle. Crops are not systematically rotated, although some farmers follow a rotation consisting of 1 year of corn or tobacco followed by small grain and lespedeza the second year. Lespedeza may follow for 2 or 3 years after the small grains. Some commercial fertilizer is used for corn and small grain, and substantial applications with some manure are used for tobacco. It is also a common practice to crop this soil for several years in succession after which it is allowed to lie idle for several years before cropping is resumed. Pasture is seldom fertilized or otherwise given special care. The vegetation consists predominantly of broomsedge and a variable quantity of brush and weeds. Under average management, corn yields about 15 bushels an acre, wheat 8 to 10 bushels, tobacco 700 pounds, and lespedeza and redtop hay 1/2 to 1 ton.

The productivity of this soil can be greatly improved although its maintenance at a high level is more difficult than that of the more fertile soils, as Emory silt loam. Moderately long rotations including legume cover crops to be turned under as green manure are well suited to this soil, and substantial applications of lime and phosphorus are also required if good yields are to be obtained. Under average conditions lespedeza and redtop are the best suited hay crops; more exacting crops, as red clover and timothy, can be grown when the fertility has been raised to a relatively high state. Pastures can be expected to improve greatly when lime and phosphorus are added and the weeds and brush eradicated. Lespedeza, redtop, and orchard grass are among the more substantial pasture plants that improve the grazing when proper fertilization is practiced.

Clarksville fine sandy loam, eroded hilly phase.—This phase differs from the eroded phase in having a stronger slope (12 to 30 percent). The surface and subsoil layers are more variable in thickness and in general are thinner than those of the less steep type. All this soil is well drained. Most of it is widely distributed over the area south of Richland Knobs.

This soil is poor cropland and fair pasture land. Its low natural fertility and strong slope make it difficult to maintain the soil in a highly productive state. Unless heavily fertilized, the less exacting meadow and pasture crops, as lespedeza and redtop, are best suited to it.

About 90 percent of this soil is cleared. Of this about 20 percent is used for corn, 20 percent for small grains, principally wheat, 30 percent for hay and temporary pasture, 10 percent for other crops, and about 10 percent lies idle. The idle land is occupied by a brushy growth, chiefly sassafras, persimmon, and briers, but some of it affords a limited quantity of grazing. Some fertilizer is commonly used for row crops and wheat, but very little manure is available and cover crops to be turned under are not commonly grown. Crop yields and the carrying capacity of pasture is low under average management. Crops and pasture respond well, however, to good management, although high yields are difficult to maintain. Long rotations consisting chiefly of close-growing small grains, hay, and pasture should be used where conditions require that the soil be cropped. Tillage operations should be on the contour and kept at a minimum. Where conditions make it feasible, permanent pasture is considered one of the best uses for this soil. Lespedeza and redtop respond well to substantial applications of lime and phosphorus.

Clarksville cherty fine sandy loam, eroded phase.—This soil has sufficient chert throughout the surface layer to interfere materially with cultivation. It is developed from arenaceous or sandy dolomitic limestone of the Knox dolomite formation. The surface is undulating to rolling and most of the areas are on rounded ridge tops. The native vegetation was mostly deciduous hardwoods, chiefly oak, hickory, sourwood, and yellow-poplar.

The separate areas of this soil are small and closely associated with other sandy Clarksville types and phases south of Richland Knobs.

A profile description of the type, similar to this phase except for the thickness of the surface layer, is as follows:

0 to 6 inches, light-gray cherty fine sandy loam or loam.
6 to 30 inches, yellow (in places reddish-yellow when moist) moderately firm but friable cherty fine sandy clay loam.
30 inches +, reddish-yellow or yellowish-red splotched with red and gray firm but crumbly fine sandy clay containing some chert. Some dolomitic limestone bedrock is at a depth of 20 to 40 feet.

The thickness of the surface layer varies greatly. The small part that has never been cultivated has a surface layer 10 to 14 inches thick, and in these areas the surface inch or two is darker gray because of the relatively high content of organic matter. In a few small areas or patches where nearly all or all of the surface soil has been lost by erosion the heavier yellow subsoil is exposed. The organic matter of the upper 2 inches of the virgin areas is not very permanent and disappears within a short time following cultivation. The permeability and internal drainage are good and the moisture-holding capacity is moderate. The soil is low in natural fertility, and is medium to strongly acid.

This soil is fair cropland. It is easily worked and runoff is not difficult to control, but it is difficult to maintain in a moderately high

productive state, and exacting crops require special fertilization. Corn, sorghums for forage, certain small grains, and lespedeza and redtop are among the better suited crops. This soil affords only fair pasture. The grazing value is not high except where heavy applications of fertilizer are made.

Most of the land is cleared and used either for crops or pasture. About 20 percent is in forest, 15 percent is idle, 20 percent is used for corn, 20 percent for hay and temporary pasture, and 20 percent for small grains, principally wheat. Crops are not systematically rotated, although some farmers follow a rotation consisting of 1 year of corn followed by small grains and lespedeza the second year. Lespedeza may follow for 2 or 3 years after the small grain. Some commercial fertilizer is used for corn and small grain. It is also a common practice to crop this soil for several years in succession, after which it is allowed to lie idle for several years before cropping is resumed. Pastures are seldom fertilized or otherwise given special care, consequently they are of poor quality and low carrying capacity. The vegetation consists predominantly of broomsedge and some brush and weeds. Under average management, corn yields about 13 bushels, wheat 6 to 8 bushels, and lespedeza and redtop hay 1/3 to 3/4 ton an acre.

The productivity can be greatly improved although its maintenance at a high level is more difficult than that of the more fertile soils, as Emory silt loam. Moderately long rotations including legume cover crops to be turned under are well suited to this soil, and substantial applications of lime and phosphorus are required also if good yields are to be obtained. Under average conditions, lespedeza and redtop are the best suited hay crops, yet more exacting crops, as red clover and timothy, can be grown when the fertility has been increased. Pastures improve where lime and phosphorus have been applied and weeds and brushy growth eradicated. Lespedeza, redtop, and orchard grass are among the more substantial pasture plants that can be relied upon to improve the grazing when proper fertilization is practiced.

Clarksville cherty fine sandy loam, hilly phase.—This phase differs from the eroded phase in having a stronger slope and in not being eroded to an appreciable degree. Most of it is practically uneroded. The surface is hilly, the slope ranging from 12 to 25 percent. The areas are larger than those of the Clarksville soils having a smoother surface, and they commonly include ridge tops of less gradient than 12 percent that are too narrow to map as smoother phases.

This is the most extensive of the Clarksville soils and the separate areas commonly range from 50 to 250 acres. It is widely distributed south of Richland Knobs.

Because of its strong slope, chertiness, and low fertility, this soil is not well suited to crops requiring tillage. Its suitability for pasture is fair. Grazing vegetation under average conditions is less desirable than on more fertile soils. Many of the forested areas are probably best retained as forest.

Practically all this phase is forested with oak, hickory, yellow-poplar, and sourwood, with some pine. All the forest has been cut-over. Areas to be cropped will require careful management if they are to be built up to and maintained in a productive state. Long rotations consisting chiefly of small grains, hay, and pasture crops and consistent fertiliza-

tion are necessary to accomplish this. Organic matter and all of the important nutrient elements—nitrogen, phosphorus, potassium, and lime—in substantial quantities are necessary if good yields are to be obtained. Contour tillage and possibly strip cropping should be practiced in order to control runoff. This soil is suited to permanent pasture, consisting of lespedeza, redtop, and orchard grass. More exacting pasture plants, as white clover and bluegrass, can be grown with some success if their lime and phosphorus requirements are fulfilled. With proper management, oats yield about 18 bushels, wheat about 10 bushels, and lespedeza hay about 3/4 ton an acre.

Clarksville cherty fine sandy loam, eroded hilly phase.—Differs from the eroded phase in having a hilly rather than rolling surface and consists of areas that have been cleared and eroded to the extent that subsoil material is within plow depth over half or more of the area. The depth to subsoil material varies greatly because of the wide difference in the rate at which material was lost by erosion.

This is one of the more extensive of the Clarksville soils. The areas are relatively large and are widely distributed throughout the county south of Richland Knobs.

Because of its stronger slope, chertiness, and low fertility, this soil is not well suited to crops requiring tillage. Its suitability for pasture is poor to fair. Grazing vegetation under average conditions is less desirable than on the more fertile soils, and on the more eroded parts it is of very low value.

At one time all this soil has been cleared and cropped. About 20 percent has been reforested by pine; about 10 percent lies practically idle and is covered by an intermittent growth of sassafras, briers, and broomsedge. About 35 percent is used for pasture and hay, about 20 percent for corn, and about 15 percent for small grains. Yields of all crops under average management are low and pasture is of poor quality.

Areas required for crops should be used in a long rotation consisting chiefly of close-growing crops, as small grains, lespedeza, redtop, and orchard grass in order to keep the soil protected from erosion as much of the time as possible. Cover crops should be grown when the ground is not to be occupied by hay or fall-sown small grains in winter. Contour tillage should be practiced and strip cropping may be advantageous when the lay of the land is suitable. Lespedeza and redtop are among the more suitable pasture plants although where the fertility is raised to a high level, bluegrass and white clover can be grown with some success. Under a high level of management, including adequate fertilization, fair to moderate yields of the common field crops are obtained. Under these conditions, wheat yields about 8 bushels and lespedeza 3/4 to 1 ton of hay an acre. Substantial applications of phosphorus and lime are necessary if good grazing is to be obtained from pasture.

Included with this soil are associated areas of Fullerton cherty fine sandy loam, eroded hilly phase, too small to delineate on the map.

Clarksville cherty clay loam, severely eroded hilly phase.—This soil is developed from material derived from cherty dolomitic limestone, and the depth to bedrock ranges from 20 to 40 feet. Practically all the surface soil has been lost by erosion and in places a notable part of

the subsoil. In places there are patches that have a thin layer of the gray cherty fine sandy loam original surface layer. Gullies are not uncommon but most of them can be crossed though not obliterated by common tillage implements. The aggregate area is less than that of several of the other Clarksville soils, and the separate areas are relatively small and widely distributed in association with other Clarksville, and with Fullerton and Bolton soils.

A profile description is as follows:

0 to 24 inches, yellow moderately firm but friable cherty fine sandy clay loam. In places this may have a reddish cast, especially in the lower part.

24 inches +, reddish-yellow or yellowish-red splotched with red and gray firm but crumbly fine sandy clay containing an abundance of chert, much of which is sandy.

This severely eroded soil is low in plant nutrients, its water-holding capacity is low, and its permeability is only fair. Much of the moisture that falls on it is lost as runoff. The soil is medium to strongly acid throughout its entire depth.

This soil is poorly suited to either crops or pasture. Because of its low fertility and poor moisture relations it is unproductive, and it is difficult to work because of the poor tilth of the exposed subsoil and its high content of chert. Cultivated areas are difficult to protect from erosion because of the strong slope and the difficulty of maintaining a protective vegetative cover. Most areas are best suited to forest.

All this soil has been cultivated at sometime but approximately 60 percent is either reforested with pine, lies idle, or is used as unimproved pasture. The idle land and unimproved pasture have an intermittent cover of sassafras, persimmon, and briers and the chief grazing vegetation is broomsedge. The grazing capacity is low on these areas. Lespedeza, wheat, and corn are the chief crops grown on the remaining part. Yields of all crops are low.

Under average conditions the soil is best used for forest. If it is to be improved for either pasture or crops, considerable effort must be made to improve its water-holding capacity and fertility. Much organic matter needs to be added and substantial applications of fertilizer and lime made. Long rotations consisting chiefly of close-growing crops should be used and all cultivation should be on the contour.

In places there are areas that have a thin surface layer of gray cherty fine sandy loam. Included also are areas of the severely eroded hilly phases of Clarksville cherty silty clay loam and Clarksville sandy clay loam. These have been included chiefly because of their similarity from the standpoint of characteristics and suitability for use and limited area.

Colbert silt loam.—This yellow plastic soil of the upland is shallow to bedrock limestone. The parent rock is clayey (argillaceous) limestone of the Chickamauga formation. The small aggregate area occupies smooth to undulating valley positions. In general surface drainage is adequate, but internal drainage is notably retarded. The native vegetation was predominantly deciduous hardwoods associated with some cedar. Practically all the type is in Clinch Valley.

A profile description is as follows:

0 to 6 inches, brownish-gray or yellowish-gray silt loam.
6 to 24 inches, yellow mottled with gray and a little red and brown plastic silty clay. In places, this layer rests on bedrock.
24 to 36 inches, mottled gray, yellow, and olive-yellow plastic clay. Clayey limestone bedrock is at a depth of 20 to 40 inches.

Although the underlying rock is calcareous, the reaction is acid throughout the entire profile. About half of the soil has lost 50 to 75 percent of its surface soil by erosion and much subsoil material is mixed with the surface material. Limestone fragments, 2 to 15 inches in diameter, are common in many areas and they are generally abundant in the lower layer. A few bedrock outcrops are present.

This soil is fairly well suited to crops requiring tillage and to pasture. Its productivity is only fair, due to its moderately low fertility and rather unfavorable moisture relations. The plastic clay subsoil and the shallow depth to bedrock limit its capacity for holding moisture available to plants. Except where subsoil material is included in the surface layer, the workability of the soil is satisfactory. Here the soil is notably cloddy when dry, plastic when wet, and is suitable for working only within a narrow range of moisture conditions. Due to its slow permeability runoff develops quickly during periods of precipitation and causes erosion even on the gentle slopes. Bluegrass and white clover are suited to this soil for pasture plants, but their growth is limited by the droughty nature of the eroded parts.

Practically all this soil has been cleared and cultivated and at the present time about 35 percent is used for corn. Hay and pasture occupy most of the remaining part, although some small grain is raised. Some fertilizer and lime are used but applications are commonly light. Crop yields under average conditions are not high. Corn yields 16 to 22 bushels and lespedeza hay about 3/4 ton an acre. Good management requires the application of at least moderate quantities of phosphorus and lime and the use of barnyard manure or green-manure crops to increase the nitrogen supply and improve the tilth. Some care must be taken to avoid soil losses by runoff water. Most tracts under good management are suitable for a 3- or 4-year rotation, and under such conditions, corn, wheat, oats, barley, red clover, timothy, and on the more favorable sites, alfalfa, are suited. Good pasture of bluegrass and white clover can be expected where phosphorus and lime are applied in substantial quantities and weeds and brush are eradicated. The carrying capacity is limited, however, by the droughty nature of the soil. Under good management corn yields about 30 bushels, red clover and timothy about 1¾ tons, and wheat about 16 bushels an acre.

Colbert silty clay loam, eroded rolling phase.—This phase differs from the silt loam in having a more sloping surface and in having lost more material as a result of erosion. The slope ranges from 5 to 12 percent, and most of the land has been eroded sufficiently to cause subsoil material to be a part of the surface layer. Between 50 and 75 percent of the surface soil has been lost in most places, and practically all of it and a part of the subsoil have been eroded from a few areas.

The aggregate area of this soil is not extensive. Practically all of it is in the Clinch Valley.

This phase is not well suited to crops and is not very productive of pasture. Its natural productivity is fair and its workability and conservability are poor to fair. Because of poor moisture relations, plants suffer severely at times of drought. The less eroded and less sloping parts may be suitable for long rotations, but most of the acreage is probably best used for pasture.

Nearly all this soil has been cleared and cultivated but nearly 70 percent of it is now either idle or has reverted to forest. Cedar and pine are among the more common trees on the reforested areas. Corn and hay, chiefly lespedeza, are the principal crops. Under average management, yields are low and under good management they cannot be expected to be high. The smoother and less eroded parts that are at all suited to crops should be operated under a long rotation consisting chiefly of close-growing small grains, hay, and pasture crops, and tillage operations should be on the contour. Most of the acreage can best be used as pasture. If properly fertilized and limed, fair to good stands of bluegrass, lespedeza, and white clover may be maintained on much of it although growth is readily suppressed during periods of drought. The shallower and most eroded parts respond slowly to good management.

Cumberland silt loam.—A somewhat reddish fertile soil on the stream terraces, consisting of material derived from limestone intermixed with smaller quantities from shale and sandstone. The surface is smooth to undulating and both surface and internal drainage are good. The native vegetation consisted of oak, hickory, chestnut, yellow-poplar, maple, and other deciduous hardwoods, most of which have been either entirely removed or cut-over. The aggregate area of this soil is small. Most of it is along the Holston River. The separate areas are small and widely scattered. Part of this type was inundated by the Cherokee Reservoir.

A profile description of this type that has not been materially eroded is as follows:

0 to 14 inches, dark-brown mellow silt loam relatively high in organic matter.
14 to 50 inches, dark-red dense but permeable silty clay.
50 inches +, yellowish-red splotched with yellow and gray moderately tough but crumbly silty clay.

Small dark-brown to nearly black soft concretions are common to the subsoil and substratum. The terrace deposit is variable in thickness but it is usually greater than 3 feet and in a few places is as much as 15 feet. It is generally underlain by limestone or shale containing some limy material. The entire profile is medium to strongly acid, although the underlying bedrock is generally calcareous.

In places where the surface layer is less than 6 inches thick some subsoil material has been mixed with it by tillage. In a few places the subsoil is dark red or maroon, resembling that of the Decatur soils. The fertility is high and permeability to both roots and water is moderately good, although runoff due to impaired percolation is greater than on some soils.

This type is well suited to both crops and pasture. It is one of the most fertile soils of the county and its smooth surface, good internal drainage, and friable nature of the surface layer make it easy to work and conserve. Properly managed it is capable of being used in a relatively short rotation and is suited to a wide variety of crops.

Most of the soil has been cleared and is now used for crops and pasture. About 50 percent is used for corn, about 15 percent for tobacco, about 15 percent for small grains, and most of the rest for hay and pasture. Rotations of 2 to 4 years are commonly followed, and some fertilization is practiced. Tobacco is always heavily fertilized and much of it receives manure. Areas to be used for alfalfa are always limed and much of it fertilized with either manure or phosphate fertilizer. A common rotation consists of 1 year to corn or tobacco, 1 year to small grains, and 1 year to lespedeza or some other hay crop. If the hay crop is seeded with the small grain, one cutting is made in the fall after the grain has been harvested. Under average management, corn yields about 36 bushels, wheat about 18, and alfalfa about 3¼ tons an acre. Yields of these crops are somewhat better under a high level of management. Although this soil is naturally fertile, good response to moderately heavy applications of phosphorus, lime, and manure can be expected. If this soil is to be maintained in a highly productive state, some attention must be given to the control of runoff on the more sloping areas. Close-growing grain, hay, and winter cover crops, and on the more sloping parts, contour tillage, will do much toward minimizing the hazards of runoff water.

Cumberland silty clay loam, eroded sloping phase.—Differs from the silt loam in having a stronger slope and in being more eroded, and occurs on stream terraces consisting of material predominantly from limestone intermixed with that from shale and sandstone. The surface is smooth to undulating and internal drainage is medium, though slightly impaired. The soil occurs along the Holston River. The separate areas are small and widely scattered over this part of the county. Part of this phase was inundated by the Cherokee Reservoir. The native vegetation was oak, hickory, chestnut, yellow-poplar, maple, and other deciduous hardwoods.

A profile description is as follows:

0 to 5 inches, reddish-brown moderately friable silty clay loam.
5 to 40 inches, dark-red dense but permeable silty clay.
40 inches +, yellowish-red splotched with yellow and gray, moderately tough but crumbly silty clay.

From 50 to 75 percent of the original surface soil has been lost by erosion, and in places practically all of it and part of the subsoil has been lost. In these places the plow layer consists of red dense though crumbly silty clay.

Dark-brown to nearly black soft concretions are common to the subsoil and substratum. The terrace deposit in which this soil developed is variable in thickness, but it is generally greater than 2 feet and ranges up to 10 or 12. It is generally underlain by limestone or shale containing limy material. The entire profile is medium to strongly acid, although the underlying bedrock is generally calcareous.

The phase is suited to both crops and pasture. Its stronger slope

and more eroded condition make it more difficult to work and conserve than the silt loam, and its productivity is somewhat lower. The most severely eroded slopes should be used for permanent pasture.

Most of this soil has been cleared and practically all of it is being used either for crops or pasture. Corn and tobacco occupy about 35 percent of the acreage, hay and pasture about 45 percent, and most of the rest is used for small grains. Crops are rotated on most areas and irregular fertilization is practiced. Yields in general are lower than on the silt loams. Under average management, corn yields about 32 bushels; wheat about 16; tobacco about 1,100 pounds, and alfalfa about 2½ tons an acre. Areas prepared for alfalfa receive an application of 2 or 3 tons of lime and may receive some manure or phosphorus fertilizer.

Somewhat longer rotations should be used than on the silt loam in order to avoid serious losses by erosion. More effort should be made to keep a close-growing vegetative cover on the soil and for this purpose winter cover crops, hay, and pasture should occupy the soil most of the time. The most sloping severely eroded areas should be used for permanent pasture until their fertility has been increased to where they can produce more luxuriant stands. Some of the more severely eroded places are now unproductive and in order to increase their fertility, substantial applications of manure or other fertilizers are required.

Included with this soil are a few areas of Etowah silty clay loam, eroded sloping phase, which have a lighter brown surface soil and a yellowish-brown silty clay loam subsoil generally a little more friable than the subsoil of the type.

Decatur silty clay loam, eroded phase.—A rolling, well-drained and fertile soil of the uplands, developed over high-grade limestone. The slope ranges from 5 to 12 percent. This is the most extensive of the Decatur soils, although its aggregate area is small. Practically all of it is in Richland Valley. The 90 acres in Mitchell Bend are a purplish variation developed from material of the Tellico geologic formation. The native vegetation consisted of oak, hickory, chestnut, maple, and other deciduous hardwoods.

A profile description is as follows:

0 to 5 inches, reddish-brown moderately friable silty clay loam.

5 to 40 inches, dark-red or maroon-red firm dense but permeable silty clay, containing some soft dark-brown to nearly black concretions. The depth to which this layer extends ranges from 35 to 80 inches.

40 inches +, yellowish-red mottled with gray and brown rather tough silty clay. Where bedrock limestone is at a depth of 5 feet, the layer may not be more than 18 inches thick; where the limestone is 20 feet deep, it is correspondingly thicker; and where the depth to the bedrock is great, the lower part of this third layer or substratum is yellower.

The surface soil material is mixed with a variable quantity of subsoil material, most of which has lost 50 to 75 percent of the original surface layer as a result of erosion. There are small patches where all the surface soil has been removed, leaving the subsoil exposed. In some places the parent rock included shaly lenses, and in these areas the soil has a noticeable quantity of shale fragments in the substratum. In these

areas this substratum is less reddish and is not so thick over bedrock.

This soil is suited to crops and pasture, but it requires more careful management than the smoother phase. It is a little more difficult to work and because of its slope and rather slow permeability, its proper conservation is much more of a problem.

All this soil has been cleared and most of it is used either for crops or for pasture. About 40 percent is used for corn and other row crops including tobacco, about 40 percent for hay and pasture, and most of the rest for small grains. Most areas are farmed under a moderately long rotation and some fertilization is practiced, especially on the more exacting crops, as tobacco and alfalfa. Average yields for corn are about 33 bushels, barley about 20 bushels, and alfalfa about 2¾ tons an acre.

Proper management requires special attention to control water. Where row crops are grown frequently and the surface is left bare following removal of crops, erosion is very active. Rotations in which row crops are not grown frequently and which include winter cover crops, as crimson clover, are well suited to this soil. All the small grains, including barley, are well suited; and the more exacting hay crops, alfalfa, red clover, and timothy, are grown successfully, although the legumes require lime and probably phosphorus in order to establish and maintain good stands. Contour tillage and possibly strip cropping should be practiced as means of restraining erosion. Although this is one of the more fertile soils of the county, fertilization and the addition of organic matter are necessary to maintain a high productivity.

Decatur silty clay loam, severely eroded phase.—This phase differs from the eroded undulating phase in having a stronger slope (5 to 12 percent) and in being more eroded. Practically all the surface soil and in places part of the subsoil have been lost by erosion. The surface layer consists of brownish-red or dark-red dense silty clay and differs very little from the underlying subsoil. In some areas a few gullies are as much as 2 feet deep and not crossable with farm machinery. The entire soil mass is medium to strongly acid and practically all of it is associated with the other Decatur soils in Richland Valley. Most of the areas are small.

The moderately strong slope and the heavy consistence of the surface layer limit the suitability of this soil. Moisture relations are not so favorable as in the eroded Decatur soils, and the fertility of the surface layer is much lower. The slope and slow permeability enhance runoff, and the heavy nature of the surface layer causes tillage to be difficult. The soil is fair cropland and good pasture land.

All this soil has been cleared and cultivated. About 15 percent is idle or reforested, about 30 percent is used for corn, about 35 percent for hay and pasture in rotation, and about 20 percent for small grains and other crops. Yields vary greatly according to the level of management but in general they are low. Under average management, corn yields about 10 bushels, wheat about 5 bushels, and lespedeza hay about 1/3 ton an acre. The chief limiting factor to increased yields is the low capacity of this soil for holding moisture available to plants. Some improvement in this respect may be obtained by increasing the permeability of the soil by the addition of organic matter. Manure and cover crops, as sweetclover and sericea lespedeza, are of particular value for

this purpose. Plant nutrients, especially phosphorus and nitrogen, and lime are required in substantial quantities if a high state of fertility is to be obtained. Tillage should be kept at a minimum, and for this purpose relatively long rotations consisting of close-growing crops should be used. Fall-sown small grains, winter cover crops, and hay and pasture crops should make up a great part of the rotations, and row crops and crops, as peas and beans, should be kept at a minimum. Tillage operations should be on the contour where feasible, and strip cropping may be beneficial. Where feasible, permanent pasture is a good use for this soil, and when the fertility is at a relatively high level, bluegrass and white clover can be established. Hay crops, as red clover, timothy, and alfalfa, are suited to this soil where the tilth has been improved and lime and phosphorus applied. Crop yields under a high level of management, though limited by moisture relations, are greater than under average management. Under this management corn yields about 25 bushels, wheat about 10 bushels, lespedeza about ¾ ton, and alfalfa about 1½ tons an acre.

Decatur silty clay loam, eroded undulating phase.—A dark-red smooth to undulating productive soil developed over high-grade limestone of the uplands. It is a well-drained fertile soil occupying valley positions. From 50 to 75 percent of the surface soil has been lost by erosion; however, there are some areas that have not materially eroded. Most of the soil lies over Rutledge limestone in comparatively small areas widely distributed in Richland Valley. The native vegetation consisted of oak, hickory, maple, chestnut, and other deciduous trees.

A profile description of a comparatively uneroded area is as follows:

0 to 14 inches, dark-brown mellow silt loam.

14 to 50 inches, dark-red or maroon-red firm dense brittle silty clay, containing some soft dark-brown to nearly black concretions. This layer extends to a depth of 45 to 80 inches.

50 inches +, yellowish-red mottled with gray and brown tough silty clay. The thickness of this layer varies considerably; where bedrock limestone is at a depth of 5 feet, it may not be more than 18 inches thick; where the limestone is at a depth of 20 feet, it is correspondingly thicker; where the depth to the bedrock is great, the lower part of this third layer, or substratum, is yellower.

The thickness of the surface layer varies according to the quantity of erosion that has taken place. Where erosion has reduced the surface layer to a thickness of less than 6 inches, the somewhat silty clay of the subsoil has been mixed with the surface-layer material by tillage. In these areas the surface layer is redder, and the texture is more nearly silty clay loam or silty clay. In some places the parent rock included shaly lenses, and the soil from this material has a noticeable quantity of small soft shale fragments in the substratum, which is less red and does not extend to so great a depth as where the soil is developed entirely from limestone.

This is one of the most suitable soils for crops and pasture. It is very productive and under good management is not difficult to till and conserve. Because of its rather heavy consistence, it is harder to till than

some of the coarser textured soils, and runoff develops more rapidly during periods of precipitation than on some of the more permeable soils. The relative ease with which a good vegetative cover can be maintained helps in controlling runoff. This phase is comparatively well suited to the most exacting crops commonly grown, including alfalfa, red and white clover, timothy, bluegrass, barley, and tobacco.

Practically all this soil has been cleared and is now used for crops. About 45 percent of the acreage is used for corn, 10 to 15 percent for tobacco, 20 to 30 percent for hay and pasture, and 15 percent for small grains. Some fertilization is practiced, and crops are commonly rotated. In general row crops are grown frequently and in some cases they are grown several years in succession. Lime has been applied to a large part of the acreage, and some fertilizers, especially phosphorus and manure, are used. Under average management corn yields about 35 bushels, barley about 23, and alfalfa hay about 3¼ tons an acre. If this soil is to be maintained in a highly productive state, somewhat longer rotations should be used than are now commonly practiced. Row crops should not be grown more than once in 2 or 3 years. Legume hay, cover, and pasture crops should be in more common use. Where the fertility is well maintained, crimson clover is the preferred cover crop. Although erosion is not a hazard, some care must be taken to guard against it. Less frequent row crops, the regular use of winter cover crops, and, on the more sloping parts, contour tillage, will do much towards suppressing erosion.

Decatur silty clay loam, eroded hilly phase.—This soil differs from the eroded undulating phase in having a greater slope (12 to 25 percent). The thickness of the surface soil varies considerably according to the quantity of erosion that has taken place. A few areas are virtually uneroded and here the 10- to 12-inch surface soil is dark-brown silt loam. Below this is red or dark-red firm slowly permeable silty clay. Bedrock ranges from 5 to 20 feet, and there are a few rock outcrops on the steepest slopes. A small acreage is developed over the pink marble of the lower part of the Tellico geologic formation and these areas have a somewhat purple silty clay subsoil. The cleared and tilled areas have a surface layer usually less than 7 inches thick, and a great part of it consists of a mixture of subsoil and surface soil material. Internal drainage is adequate for plant growth, and the soil is permeable to roots, although moisture infiltration is less favorable than in some soils. The natural fertility is high, and the entire soil is moderately to strongly acid. The natural vegetation consisted chiefly of oak, hickory, maple, and other deciduous hardwoods. The small areas of this phase are widely distributed throughout Richland Valley.

The strong slope and slow infiltration of moisture limit the suitability of this soil for crops, but its high natural fertility makes it well suited to pasture. The strong slope and moderately heavy consistence make it a rather difficult soil to work.

About 85 percent of this soil has been cleared and cultivated. About 25 percent is used for corn, 40 percent for hay and pasture in rotation, and 20 percent for small grains and other crops. Only a small part is idle. Yields under average conditions are fair, that of corn is about 25 bushels, wheat 12 bushels, and lespedeza hay about 1 ton an acre.

Some fertilization is practiced, but most of the fertilizer is used in small quantities for the row crops. Lime has been applied at the rate of about 2½ tons an acre to some of the acreage, and manure is commonly used where it is available.

Long rotations should be used and particular effort made to keep this soil occupied by close-growing crops. Where the fertility is maintained, all the small grains and the more exacting hay and pasture plants, as red clover, alfalfa, white clover, timothy, and bluegrass are suited; where the ground would otherwise lie bare through winter, a cover crop should be sown; and where fertility has been maintained, crimson clover is probably the preferred crop for this purpose. Although this is a relatively strong soil, maintenance of its fertility at a high level requires at least some fertilization. Lime and phosphorus are the chief mineral requirements and applications of these are particularly essential if red clover, alfalfa, or white clover are to be established. Care should be taken in tillage practices to avoid enhancing erosion by runoff. Tillage should be kept at a minimum and, where feasible, should be on the contour. Strip cropping may be beneficial but terracing probably will not be practiced.

Permanent pasture is one of the best uses for this soil. Where fertility is maintained at a high level and competitive brushy and weedy growth eradicated, pasture of good quality and fairly high carrying capacity can be maintained, although growth practically ceases during the driest parts of summer.

Decatur silty clay loam, severely eroded hilly phase.—This soil differs from the eroded undulating phase because it has a stronger slope (12 to 30 percent) and has lost practically all the surface soil as a result of erosion. Gullies, 1 to 2 feet deep, though not abundant, are common except where special precautions have been taken to prevent or eliminate them. The surface layer consists of brownish-red or dark-red dense silty clay and differs little from the underlying subsoil. Bedrock is at a depth of 5 to 20 feet, and there are a very few rock outcrops on the steepest slopes. The entire soil mass is medium to strongly acid.

This is one of the less extensive of the Decatur soils. The areas are small and are widely distributed in association with other Decatur soils in Richland Valley.

The strong slope and heavy consistence of the surface layer cause this soil to be difficult to maintain in a productive state when used for crops requiring tillage. It is difficult to till, and, except under most favorable circumstances, a vegetative cover of crops requiring tillage is very difficult to maintain. Under proper management it is capable of producing a fair pasture of good quality.

All this soil has been cleared and cropped. A small part is now idle or has been reforested, about 20 percent is used for corn, 20 percent for small grain, and the rest is used chiefly for hay and permanent pasture. Crop yields are small. Corn yields about 8 bushels, wheat about 4 bushels, and lespedeza about ¼ ton of hay an acre.

Tillage should not be practiced. Permanent pasture consisting chiefly of bluegrass, white clover, and lespedeza should be established and maintained for as long periods as possible. Substantial applications of phosphorus and lime are generally necessary in establishing pasture of this nature, and manure is especially helpful in rebuilding these

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eroded areas to where they can support a good stand of pasture plants. Tillage, when necessary, should be on the contour and a crop sown that will develop an effective vegetative cover within a short time. The most severely eroded areas should be reforested.

Dewey silty clay loam, eroded phase.—This red fertile valley soil differs from Decatur silty clay loam, eroded phase, in having a lighter brown surface layer and a lighter red somewhat less dense subsoil. It is developed over high-grade limestone. Practically all this phase has been eroded. It represents areas of Dewey silt loam from which 50 to 75 percent of the original surface soil has been lost by erosion. The entire soil is medium to strongly acid.

This is the most extensive of the Dewey soils in the county. A large part of the acreage is associated with areas of the Decatur, Talbott, and Sequoia soils. Most of it is over Chickamauga limestone and Holston marble in Clinch Valley, but there are a few areas over Rutledge limestone in Richland Valley and over Rutledge limestone in the Holston River Valley. Most of the areas in this latter valley were submerged by the Cherokee Reservoir.

The surface of this soil is rolling (5 to 12 percent). Surface drainage is well developed, and internal drainage is adequate, although the dense nature of the subsoil notably impairs moisture infiltration. The native vegetation was oak, hickory, maple, chestnut, and other deciduous hardwoods.

A profile description is as follows:

0 to 7 inches, brown to light-brown mellow silt loam, grading to silty clay loam.

7 to 40 inches, light-red to brownish-red firm but moderately friable silty clay. A few small chert fragments are in the lower part.

40 inches +, yellowish-red splotched with yellow, brown, and gray, moderately sticky or plastic silty clay. In general a few small chert fragments are in this material. In most areas bedrock limestone is at a depth of 15 to 20 feet, although it is within 5 feet of the surface in some places.

The surface layer varies in thickness according to how much erosion has taken place and the quantity of mixing in the eroded areas by tillage. There are a few places where the brown silt loam layer is as much as 12 inches thick and others where the subsoil material is intermixed with a remnant of the original surface soil. Here the surface layer, which is 5 to 7 inches thick, is brownish-red silty clay loam. There is some of this soil from which practically all the original surface layer has been removed by erosion. Here the surface layer consists of red heavy silty clay subsoil material. A few areas in Richland Valley have lenses of shale in the substratum. These have a shallower depth to bedrock than do those of Dewey silt loam.

This is one of the more fertile soils of the county. It is well suited to both crops and pasture and with proper management is suited to the more exacting crops and pasture plants. Tillage is not difficult except where practically all the surface soil has been lost, but it requires careful management for proper conservation due to its rolling surface and slow rate of infiltration.

All this land has been cleared and cultivated and very little of it is now idle. Most areas are under comparatively intensive use. About 45 percent is used for corn or other row crops, chiefly tobacco, about 35 percent for small grains, and the rest for hay and pasture in rotation. Relatively short rotations are used, and some fertilization for row crops and the more exacting hay crops is practiced. Lime has been applied to much of the acreage at the rate of about 2½ tons an acre. Crop yields are fairly good under average management. Corn yields about 30 bushels, barley 20 bushels, alfalfa about 2½ tons, and tobacco about 1,100 pounds an acre.

Chiefly because of its moderate susceptibility to erosion, short rotations should be displaced by 4- or 5-year rotations. Where other management requirements are fulfilled a rotation of 1 year of a row crop followed by a fall-sown small grain seeded to a meadow crop, the latter to occupy the ground for 2 or 3 years after the small grain is suitable. Where the ground will otherwise lie bare through winter, a cover crop should be sown and where fertility is maintained at a fairly high level, crimson clover is one of the best crops for this purpose. Although this is one of the more fertile soils, consistent though moderate fertilization is necessary if a high productivity is to be maintained. Phosphorus and lime are especially required for the more exacting hay and pasture plants, as alfalfa, red clover, white clover, and bluegrass. Manure or cover crops turned under are valuable not only for maintaining a high state of fertility but also for improving the tilth and permeability, especially of the more eroded areas.

Where feasible, tillage should be on the contour and strip cropping or terracing may be a part of the proper management. Crop yields under a high level of management are fairly high. Corn yields about 45 bushels, barley about 20 bushels, alfalfa about 3 tons, and tobacco about 1,500 pounds an acre. If properly fertilized, seeded, and grazed, this soil produces a good quality pasture of relatively high carrying capacity.

Dewey silty clay loam, eroded undulating phase.—This phase differs from the eroded phase in having a smoother surface, which is undulating—the gradient rarely exceeding 5 percent. In general, also, less soil material has been lost by erosion, but in a few places all the surface soil has been lost. The 8- to 12-inch surface layer is brown silt loam underlain to a depth of about 45 inches by a light-red to brownish-red firm but moderately friable silty clay. Below this the material is yellowish-red splotched with yellow, brown, and gray moderately sticky or plastic silty clay. Small chert fragments are not uncommon to the subsoil. In areas of little erosion, the surface layer is 10 to 14 inches thick. The small aggregate area is mostly in Mooresburg, Clinch, and Richland Valleys.

This very productive soil is easily worked and is not difficult to conserve. Because it is smooth, fertile, well drained, and permeable to roots and moisture, it is well suited to all crops commonly grown in this locality.

Very little, if any, of the land is idle. Rather short rotations are used. Nearly 50 percent is used for corn, about 10 percent for tobacco, about 20 percent for small grains, and the rest for hay and pasture in rotation. Although some attention is required to maintain fertility and

to prevent erosion, management requirements are less exacting than those of the eroded phase. Some fertilization is practiced, and much of the acreage has been limed. Crop yields are comparatively high. Under average management corn yields about 33 bushels an acre, wheat about 16 bushels, and alfalfa about 3 tons. Under a high level of management, which requires especially larger applications of fertilizer than are commonly made, corn yields about 40 bushels an acre, wheat about 23 bushels, and alfalfa about 3.5 tons. The more sloping parts are sufficiently subject to erosion to justify contour tillage where feasible and the use of moderately long rotations including crops that will maintain a vegetative cover much of the time.

Emory silt loam.—A reddish-brown productive soil, developed on colluvium or local alluvium washed from Decatur, Dewey, Bolton, and the better grade Fullerton soils (pl. 5, *A*), lies as gently sloping strips of less than 5-percent gradient at the foot of slopes or along intermittent drains. The profile is moderately to strongly acid. Both surface and internal drainage are good, and erosion is not very active. The native vegetation was chiefly oak, hickory, maple, yellow-poplar, and other deciduous hardwoods.

The small aggregate areas are widely distributed throughout Richland Valley.

A profile description is as follows:

0 to 14 inches, brown mellow silt loam.
14 to 40 inches, reddish-brown or yellowish-brown firm but friable silty clay loam.
40 inches +, variable but usually light-red mottled or splotched with brown, yellow, and gray silty clay loam.

The total thickness of the colluvial material over the reddish clay formed in place over bedrock limestone is usually more than 40 inches and not uncommonly several feet. Most of the areas in the Skinfoot section are coarser textured loam than described. On the other hand, some of the areas in Clinch Valley are finer textured (silty clay loam) than described.

Because this type is fertile, permeable to roots, favorable in moisture relations, and smooth of surface, it is one of the most desirable soils of the county for agricultural use. It is easily worked and conserved, is well suited to both crops and pasture, and is one of the best soils for tobacco.

Practically all of this soil is cleared and used either for crops or for pasture. About 40 percent is used for corn, nearly 20 percent for tobacco, 15 percent for small grains, and about 25 percent for hay and pasture. Rotations on most areas are short, and on many areas row crops are grown several years in succession. Fertilization with manure or commercial fertilizer is practiced, and lime has been applied to many areas. Winter cover crops are not used extensively. Corn yields about 40 bushels an acre, wheat about 18 bushels, and alfalfa about 2¾ tons. Pasture is generally of good quality and high carrying capacity.

Management requirements are not exacting. Lime is the chief requirement where legumes, as alfalfa, red clover, or white clover are to be grown. However, if a high productivity is to be maintained, at least moderate applications of manure or other fertilizer and organic matter

A, The well-drained soils developed on colluvial and alluvial material washed from Fullerton and associated soils are used chiefly for row crops. Emory silt loam in the foreground is one of the most productive soils of the county and is easily worked and conserved. Roane silt loam, in the more distant part of the cornfield, is somewhat lower in fertility and is subject to occasional flooding by streams. Fullerton soils are in the hilly background.

B, In the roughest parts of the county the soils of the first bottoms along the creeks afford the only significant acreage of arable land. Corn is the chief crop grown on these tillable tracts. Lehew stony very fine sandy loam, eroded hilly phase, in the background has a steep slope, is low in fertility, and shallow to bedrock; it occupies a large part of the upland.

Crops respond well to good management on the less steep areas of Fullerton fine sandy loam. Good this soil. Management of this field includes adequate fertilization and liming, and strip cropp

should be made periodically. Crimson clover could be used to good advantage as a cover crop, especially in the rotations consisting largely of row crops. Some of the more sloping parts, especially those directly subject to runoff from adjoining slopes, require special measures for controlling water. Here contour tillage and possibly terraces or other means of diverting runoff are justified.

Emory silt loam, sloping phase.—This phase differs from the type in having a stronger slope (5 to 15 percent). In many places the thickness of the colluvial material is not so great, and there are some areas from which an appreciable quantity of soil material has been lost by erosion. Areas of this soil are widely distributed in a few small tracts.

Because of its stronger slope its use is somewhat more restricted than the silt loam, but it is well suited to crops and pasture. Practically all this soil has been cleared and is used for crops and pasture. About 40 percent is used for corn, 15 percent for tobacco, 15 percent for small grains, and 30 percent for hay and pasture. In general, rotations are short and fertilization, either with manure or commercial fertilizer, is practiced. Lime has been applied on much of the acreage. Winter cover crops are not used extensively. Corn yields about 33 bushels an acre, wheat 15 bushels, and alfalfa about 2¾ tons. Pasture is generally of good quality and high carrying capacity.

Management requirements are somewhat more exacting than for the type due to the greater slope. Moderately long rotations should be used to protect the soil from losses by erosion. Where feasible, areas not protected by a close-growing crop in winter should be seeded to cover crops, as crimson clover or fall-sown small grains.

Contour tillage should be practiced, and strip cropping or terracing may be justified on some areas. Liming and at least moderate fertilization either with manure or commercial fertilizer, including especially phosphorus and potash, are necessary if the productivity is to be maintained at a high level.

Etowah silt loam.—A smooth light reddish-brown soil occupies a few of the moderately low stream terraces and is silty and free of gritty material. The surface is gently undulating, and internal drainage is good. The entire profile is moderately acid. The native vegetation was probably deciduous hardwood. Most of the inextensive soil is in the Holston River Valley, along the shore line of Norris Reservoir near Indian Creek, 1 mile east and northeast of Sycamore Spring, and one small area is along Richland Creek. Some of the acreage is now inundated by the Cherokee Reservoir.

A profile description is as follows:

0 to 10 inches, mellow brown silt loam.
10 to 40 inches, yellowish-brown firm but permeable silty clay loam to silty clay.
40 inches +, faintly mottled yellow, gray, and brown friable silty clay loam.

The thickness of the surface layer varies as a result of erosion and, in a few small patches, the subsoil is exposed. In some areas in Richland Valley the subsoil is light reddish brown rather than yellowish brown. The slope varies to about 12 percent on the terrace escarp-

ments. These areas on the escarpments are narrow and include only a small part of the aggregate acreage.

This type is well suited to both crops and pasture. Except on the small acreage of the more sloping areas, it is productive, easily worked, and presents no serious problems of conservation.

About 40 percent of the soil is used for corn, 30 percent for hay and pasture, and most of the rest for small grain. Lespedeza, red clover, and alfalfa are the common hay crops. Crops are commonly rotated, and some fertilization is practiced. This is one of the most productive soils of the county. Under average management corn yields about 35 bushels an acre, wheat about 16 bushels, and lespedeza about 1.2 tons. Under proper management, including especially relatively large applications of fertilizer, tobacco, alfalfa, and truck crops do well. The ground for tobacco usually receives both manure and commercial fertilizer, and red clover and alfalfa need lime and fertilizer, especially phosphorus, if good stands are to be obtained. In general exceptionally high yields of all crops common to the area are obtained where a high level of management is practiced. Under average conditions pasture is good, but it improves considerably where substantial applications of fertilizer, especially lime and phosphorus, are made.

Fullerton silt loam, eroded phase.—A light-colored rolling soil with a thick reddish-yellow subsoil, occupying the less cherty ridges over dolomitic limestone. It is developed from dolomitic limestone. It differs from the eroded phase of the cherty silt loam in being free of chert throughout. Most of the areas are on ridge tops and have an undulating to rolling surface.

The aggregate area is not large, and most of the separate areas occupy less than 20 acres. They are associated with other Fullerton and Bolton soils in the vicinity of Hinds and Copper Ridges. The native vegetation was chiefly oak, hickory, and tuliptree, with some shortleaf pine intermixed, and other deciduous hardwoods.

A profile description is as follows:

0 to 5 inches, brownish-gray or grayish-yellow silt loam. The few uneroded areas included in this phase have a 12-inch brownish-gray silt loam surface layer.

5 to 12 inches, light reddish-yellow firm but permeable silt loam or silty clay loam.

12 to 45 inches, reddish-yellow firm moderately sticky when wet silty clay loam or silty clay.

45 inches +, splotched reddish-yellow, yellow, brown, and gray moderately plastic silty clay. Bedrock dolomitic limestone is at a depth of 15 to 30 feet.

The entire soil is medium to strongly acid and low in plant nutrients. It is permeable to roots, and internal drainage is good, although the movement of moisture is somewhat retarded.

This soil is suited to most of the crops commonly grown and when properly fertilized, it is suited to pasture. Its low fertility limits its productivity, but its good tilth, smooth to rolling surface, and good permeability are favorable from the standpoint of workability and conservability. The uneroded and least eroded areas have better tilth

than the average due to the absence of subsoil material intermixed with the original surface layer material.

All but a very small acreage has been cropped. About 35 percent is used for corn, about 40 percent for hay and pasture, about 20 percent for small grain, tobacco, and other crops, and about 5 percent is idle. Lespedeza is the main hay crop and wheat the main small grain. Some fertilizer is used and lime has been applied to a notable acreage. Most of the fertilizer is used for tobacco and corn, although some is used for small grains. Lime has been applied chiefly for legume hay and pasture. Crops are commonly rotated, although the practice is not consistent. A common rotation is 1 year to corn or tobacco, 1 year to small grain, and 1 or 2 years to lespedeza. Under average conditions, corn yields about 25 bushels, wheat about 11 bushels, tobacco about 1,000 pounds, and lespedeza about 0.7 ton an acre.

Good management for general farm crops includes the application of lime and phosphorus and the increase of organic matter either by applications of barnyard manure or by turning under green-manure crops. The soil should be kept under a growing vegetative cover as much of the time as possible, and moderately long rotations consisting chiefly of hay and fall-sown small grains are well suited. Row crops should be grown only at moderately long intervals. Red clover and alfalfa do fairly well when the soil has been limed and built to a high state of fertility. Unless these improvements have been made, hay crops as lespedeza and redtop are generally more practical. Most of this soil should be tilled on the contour, and it may be that terracing and strip cropping are practical in places.

Fullerton silt loam, hilly phase.—A light-colored hilly soil with a thick reddish-yellow subsoil, occupying the less cherty ridge slopes over dolomitic limestone. It is developed from the underlying dolomitic limestone. It differs from the hilly phase of the cherty silt loam chiefly in being free of chert throughout. The surface is hilly (12 to 25 percent). Although most surface drainage is by surface drainageways, some is to underground channels through sinkholes. Some areas occupy only ridge slopes but some include the associated smoother but narrow ridge tops. The aggregate area is small, and the separate areas are distributed near Hinds and Copper Ridges. The native vegetation was chiefly oak, hickory, and tuliptree, with some shortleaf pine intermixed, and other deciduous hardwoods.

A profile description is as follows:

0 to 10 inches, brownish-gray silt loam.
10 to 18 inches, light reddish-yellow firm but permeable silty clay loam.
18 to 45 inches, reddish-yellow firm moderately sticky when wet silty clay.
45 inches +, splotched reddish-yellow, yellow, brown, and gray moderately plastic silty clay. Bedrock dolomitic limestone is at a depth of 10 to 30 feet.

The entire soil is medium to strongly acid and low in plant nutrients. Its fertility averages a little more than that of the hilly phase of the cherty silt loam. The soil mass is permeable to roots, and internal drainage is good although infiltration of water is somewhat retarded.

The low fertility and strong slope cause this soil to be only fairly or poorly suited to crops requiring tillage. The strong slope makes it difficult to work with heavy machinery, and it is difficult to control water on it when in a tilled condition. When properly managed, it is suited to pasture and most areas are suited to a rotation consisting of close-growing crops.

Much of this soil is occupied by forest and has not been tilled. Pasture of fairly good quality can be established if lime and phosphorus are applied, and on much of it a rotation consisting entirely of close-growing crops is feasible. Areas that are tilled should be protected by a vegetative cover as much of the time as possible and for this purpose fall-sown small grains and grasses and legumes that live through the winter should be used. Areas used for crops will require additions of organic matter, phosphorus, potassium, and lime in order to be maintained in a relatively productive state. Tillage at all times should be on the contour and under some conditions diversion of runoff water may be practical. Terracing is considered impractical on soils having a slope as great as that characteristic of this soil.

Fullerton silt loam, eroded hilly phase.—As a result of erosion this soil differs from the hilly phase in having lost 50 to 75 percent of the original surface layer. The subsoil is within plow depth over about half of its area and, here, tillage has mixed subsoil with the original surface layer. There are limited areas where the plow layer is still entirely within the original surface layer, although a part of it has been lost. On the other hand, there are a few small patches where the plow layer consists largely of subsoil material. The surface is hilly, the gradient ranging from 12 to 25 percent. The aggregate area is not large, and the areas are widely distributed near Hinds and Copper Ridges.

A profile description is as follows:

0 to 5 inches, brownish-gray or grayish-yellow firm silt loam that is 5 to 10 inches thick in the less eroded parts.

5 to 16 inches, reddish-yellow firm but friable silty clay loam.

16 to 45 inches, reddish-yellow firm moderately sticky when wet silty clay.

45 inches +, splotched reddish-yellow, yellow, brown, and gray moderately plastic silty clay. Bedrock dolomitic limestone is at a depth of 15 to 30 feet.

The soil is medium to strongly acid throughout. It is permeable to roots and though infiltration of moisture is somewhat retarded, internal drainage is good. Its organic-matter content and its natural fertility are not high.

The low fertility and strong slope cause this soil to be only fairly to poorly suited to crops requiring tillage. Because of the strong slope and the less favorable tilth of the more eroded parts, its productivity is fair, but its workability is poor. Its conservability is only fair, because of the difficulty of controlling runoff water when the soil is tilled.

All this soil has been cleared and cropped, but about 20 percent has reverted to forest or unimproved pasture. About 25 percent is used for corn, about 40 percent for hay and pasture, and about 15 percent for small grains and other crops. Fertilization is not practiced consistently except for the very small acreage of tobacco and other special crops.

Lime has been applied to some acreage at the rate of 2 tons an acre. Crops are rotated some. It is a common practice to crop this soil several years in succession and then allow it to lie idle for several years before cropping is resumed for a period. Under average management yields are low. Corn yields about 20 bushels, wheat about 10, and lespedeza about 0.5 ton an acre. Pasture is not commonly fertilized, and the grazing vegetation consists chiefly of broomsedge except where lespedeza is maintained or fertilizer and lime is applied. Areas used for pasture for several years develop a brushy cover of sassafras, persimmon, briers, and other coarse unedible growth unless special effort is made to suppress it.

Good management precludes the use of row crops and pasture is considered to be the use to which the soil is best suited. Circumstances, however, may justify using a rotation of close-growing small grain, pasture, and hay crops. A rotation of fall-sown small grain and lespedeza has proven practical in some cases. Substantial applications of fertilizer, especially phosphorus and lime, are necessary if good yields are to be obtained or if red clover or alfalfa are to be grown.

Good response to potassium fertilizer may be expected, especially if the other fertilizer requirements necessary for a relatively high productivity are fulfilled. With adequate fertilization, the maintenance of a moderatively high organic content, and a rotation consisting chiefly of close-growing small grains and grass and legume hay crops, wheat yields about 14 bushels, barley about 24 bushels, lespedeza about 1.1 tons, and red clover about 1.5 tons an acre. Lime and phosphorus are especially beneficial in improving the quality and carrying capacity of pasture. Lespedeza, redtop, and orchard grass are well suited to this phase and where the fertility has been brought to a high level, bluegrass and white clover will commonly comprise a part of the pasture vegetation.

Fullerton cherty silt loam.—A light-colored rolling soil with a thick reddish-yellow subsoil formed from cherty limestone and occupying some of the cherty ridges. The surface is undulating to rolling, and internal drainage is very good. Natural vegetation is predominantly oak, hickory, and tuliptree, with some shortleaf pine intermixed. This is not an extensive soil. Areas are small and associated with phases of the type. It is near Hinds and Copper Ridges.

A profile description is as follows:

0 to 12 inches, brownish-gray cherty silt loam stained dark in the upper inch or two with organic matter.

12 to 20 inches, light reddish-yellow firm but permeable cherty silty clay loam or cherty silty clay.

20 to 50 inches, reddish-yellow firm moderately sticky when wet cherty silty clay loam or silty clay.

50 inches +, splotched reddish-yellow, yellow, brown, and gray moderately plastic cherty silty clay. Bedrock cherty dolomitic limestone is at a depth of 15 to 30 feet.

The entire soil mass is medium to strongly acid and is low in plant nutrients. It is permeable to roots, but infiltration of water is somewhat retarded.

This soil is suited to most of the crops commonly grown and, when properly fertilized, it is suited to pasture. Its low fertility limits its

productivity but its good tilth, smooth surface, and good permeability are favorable from the standpoint of workability and conservability. The cherty nature interferes somewhat with cultivation, especially hand cultivation.

Most of the soil is under forest. Under average management, which includes light fertilization and lespedeza as a legume in an irregular rotation, corn yields about 22 bushels, wheat about 10 bushels, and lespedeza about 0.6 ton an acre. The soil is responsive to good management, however, and with substantial fertilization including lime and the use of legumes in a rotation for hay, pasture, and winter cover crops, corn can be expected to yield about 33 bushels, wheat 14 to 18 bushels, and red clover about 1½ tons an acre. Where good management, including proper fertilization, is practiced, good yields of high quality tobacco can be obtained.

Fullerton cherty silt loam, eroded phase.—As a result of erosion, which varies widely, this soil differs from the type in having lost 50 to 75 percent of the original surface layer. The subsoil is within plow depth over a half or more of the area and here tillage has mixed subsoil material with the original surface layer. There are some tracts where the plow layer is still entirely within the original surface layer; there are others where all the original surface layer has been lost and the plow layer consists entirely of subsoil material.

The 4- to 7-inch surface layer is brownish-gray or grayish-yellow cherty silt loam. Below this is light reddish-yellow firm but moderately friable cherty silty clay loam or cherty silty clay. At a depth of about 16 inches is reddish-yellow firm moderately sticky when wet cherty silty clay and below 45 inches is splotched reddish-yellow, yellow, brown, and gray moderately plastic cherty silty clay. Bedrock cherty dolomitic limestone is at a depth of 15 to 30 feet.

The soil is medium to strongly acid throughout. It is permeable to roots and, although infiltration of water is somewhat retarded, internal drainage is good. This phase represents essentially those rolling areas of the type that have been cultivated for several years. It occurs in the vicinity of Hinds and Copper Ridges.

In general this phase is suited to most of the crops commonly grown and when properly fertilized is suited to pasture. Its low fertility limits its productivity and the most eroded patches, though not extensive, are difficult to work and are much less productive, chiefly because of the unfavorable moisture relations and low fertility. The rolling surface causes runoff to be a hazard.

All this soil has been cleared. About 35 percent is used for corn, about 40 percent for hay and pasture, about 20 percent for small grain, tobacco, and other crops, and about 5 percent is idle. Lespedeza is the main hay crop and wheat the main small grain. Some fertilizer is used and lime has been applied to a considerable acreage. Most of the fertilizer is used for tobacco, corn, and wheat; and the lime, for legume hay and pasture. Crops are commonly rotated, although the practice is not consistent and universal. A common rotation is corn or tobacco 1 year, small grain 1 year, and lespedeza 1 or 2 years. Under average conditions corn yields about 20 bushels, wheat about 8 bushels, tobacco about 800 pounds, and lespedeza 0.5 ton an acre.

This soil is low in all plant nutrients, and good management for gen-

eral farming includes the application of lime and phosphorus and the increase of organic matter, either by turning under green manure or by applications of barnyard manure. It should be kept under a growing vegetative cover as much of the time as possible and for this purpose, moderately long rotations, consisting chiefly of hay and fall-sown small grains, are well suited. Red clover and alfalfa do fairly well where the soil has been built up to a high state of fertility and has been limed. Unless these improvements have been made, such hay crops as lespedeza and redtop are more practical. Most of this soil should be tilled on the contour, and it may be that terracing and strip cropping are practical in places.

Fullerton cherty silt loam, hilly phase.—Though associated with other phases of the type, this soil differs from the normal phase in having a more sloping surface (12 to 25 percent). It is developed from cherty dolomitic limestone. All is near Hinds and Copper Ridges. The separate areas are larger than those of the smoother Fullerton soils, and a large part of the acreage is on ridge slopes rather than on crests. Many areas, however, include the less sloping ridge crests because of the impracticability of delineating them separately on the map. Surface drainage is well developed, but some of it is to strongly sloping sinkholes rather than to open drainways. Native vegetation was predominantly oak, hickory, and tuliptree, with some shortleaf pine intermixed.

A profile is as follows:

0 to 10 inches, brownish-gray cherty silt loam.
10 to 18 inches, light reddish-yellow firm but permeable cherty silty clay loam.
18 to 45 inches, reddish-yellow firm moderately sticky when wet cherty silty clay.
45 inches +, splotched reddish-yellow, yellow, brown, and gray moderately plastic cherty silty clay. Bedrock cherty dolomitic limestone is at a depth of 10 to 30 feet.

The entire soil is medium to strongly acid and is low in plant nutrients. It is permeable to roots, but infiltration of water is somewhat retarded.

Chiefly because of its moderately low fertility and strong slope, this soil is not well suited to crops requiring tillage. It is not easily worked, water is difficult to control, and yields are low. It is, however, suited to pasture, but good quality grazing requires proper fertilization. Chert interferes with cultivation, especially hand cultivation.

Much of this soil is occupied by forest and has not been tilled. Pasture of fairly good quality can be established on it if lime and phosphorus are applied, and on much of it a rotation consisting entirely of close-growing crops is feasible. Tilled areas should be protected by a vegetative cover as much of the time as possible, and for this purpose fall-sown small grains and grasses and legumes that live through the winter should be used, At all times tillage should be on the contour. Although terracing may be practical on the smoother phases, the slopes of the phase in general are too strong to be suitable for this practice. Under good management, wheat yields about 13 bushels, oats about 26 bushels, and red clover about 1⅓ tons an acre.

Included with this soil are areas of Clarksville cherty silt loam, hilly phase, too small to delineate on the soil map.

Fullerton cherty silt loam, eroded hilly phase.—As a result of erosion, which varies widely, this phase differs from the hilly phase in having lost 50 to 75 percent of the original surface layer. The subsoil is within plow depth over a half or more of the area and here tillage has mixed subsoil material with the original surface layer. There are some tracts where the plow layer is still entirely within the original surface layer, but there are also small patches where all the original surface layer has been lost and the plow layer consists entirely of subsoil material.

A profile description where a substantial part of the original surface layer remains is as follows:

0 to 6 inches, brownish-gray or grayish-yellow cherty silt loam.
6 to 16 inches, light reddish-yellow firm but moderately friable cherty silty clay loam or cherty silty clay.
16 to 45 inches, reddish-yellow firm moderately sticky when wet cherty silty clay.
45 inches +, splotched reddish-yellow, brown, and gray moderately plastic cherty silty clay. Bedrock of cherty dolomitic limestone is at a depth of 10 to 30 feet.

The entire soil mass is medium to strongly acid and is low in plant nutrients. It is permeable to roots but infiltration of water is somewhat retarded.

This is one of the most extensive of the Fullerton soils. The areas are larger than those of the smoother Fullerton soils, and they are associated with other Fullerton soils and with the Bolton. All of them are near Hinds and Copper Ridges.

Because of its moderately low fertility and strong slope, this soil is not well suited to crops requiring tillage, is not easily worked, and water is difficult to control. This type is suited to pasture, but good quality grazing requires proper fertilization.

All this soil has been cleared and cropped but about 20 percent has reverted to forest or unimproved pasture. About 25 percent is used for corn, about 40 percent for hay and pasture, and about 15 percent for small grains and other crops. Fertilization is not practiced consistently except for the very small acreage of tobacco and other special crops. Lime has been applied to some areas at the rate of about 2 tons an acre. Crops are rotated, and it is a common practice to crop this soil for several years, thereafter allowing it to lie idle for several years, after which cropping is resumed for a period. Under average management yields are low. Corn yields about 15 bushels, wheat 7 bushels, and lespedeza about 0.4 ton an acre. Pasture is not commonly fertilized, and the grazing vegetation consists chiefly of broomsedge, except where lespedeza is maintained or fertilizer and lime are applied. Areas used as pasture for several years develop a brushy cover of sassafras, persimmon, briers, and other coarse unedible growth unless particular effort is made to suppress it.

Good management precludes row crops, therefore it is best suited to pasture. Circumstances, however, may justify using a rotation of close-growing small grain and pasture and hay crops. In some cases a rotation of fall-sown small grain and lespedeza has proven practical. Substantial applications of fertilizer, especially phosphorus and lime, are

necessary if good yields of these crops are to be obtained or if red clover or alfalfa are to be grown. The soil also needs organic matter, and where barnyard manure is not available, green-manure crops should be a part of the rotation. Pasture plants respond well to fertilization. Substantial applications of lime and phosphorus commonly improve the quality and carrying capacity of grazing areas and with such treatment and proper seeding, broomsedge is generally displaced by lespedeza, redtop, orchard grass, and to some extent by bluegrass and clover.

Included with this soil are areas of Clarksville cherty silt loam too small to delineate on the soil map.

Fullerton cherty silt loam, steep phase.—This soil differs from the type in having a steep rather than rolling surface and in having a shallower depth to the parent material, or substratum. It is developed from cherty dolomitic limestone. The natural vegetation was predominantly oak, hickory, and tuliptree, with some shortleaf pine intermixed. One of the more extensive of the Fullerton soils, it is distributed as comparatively large areas near Hinds and Copper Ridges.

A profile description is as follows:

0 to 10 inches, 6- to 12-inch brownish-gray cherty silt loam.

10 to 16 inches, light reddish-yellow firm but moderately permeable cherty silty clay.

16 to 40 inches, splotched reddish-yellow, yellow, brown, and gray moderately plastic cherty silty clay. Bedrock dolomitic limestone is at a depth of 10 to 30 feet, with occasional small outcrops on the steepest slopes.

The entire soil is moderately to strongly acid, low in plant nutrients, and infiltration of water is somewhat retarded, although it is permeable to plant roots. Because of its steep slope and low natural fertility, this type is not well suited to crops and under average conditions is best used for forest. However, with proper fertilization and careful management some areas are capable of affording fair to good pasture.

All this soil is under forest to which it is best suited. Areas for pasture should be fertilized with phosphorus and lime and seeded to lespedeza, redtop, and orchard grass, and where the fertility is relatively high, seeding with bluegrass and white clover may be justified. Brushy and weedy growth requires cutting or other means of suppression and care must be practiced in grazing to avoid starting of gullies.

Fullerton cherty silt loam, eroded steep phase.—Represents areas of the steep phase that have lost 50 to 75 percent of the surface layer as a result of widely varying erosion. This soil is developed from dolomitic limestone. The subsoil is within plow depth over a half or more of its area and here tillage has mixed subsoil material with the original surface layer. There are limited tracts where the plow layer is still entirely within the original surface layer, but there are also small patches where all the original surface layer has been lost and the plow layer now consists entirely of subsoil material. Its surface is steep (30 to 60 percent), and gullies 2 to 4 feet deep are common and interfere materially with field operations. Measures should be taken to arrest the further development of the gullies and some of these may require engineering practices. Most of the surface drainage is through

open surface drainways, but some is to sinkholes. All this soil is near Hinds and Copper Ridges. Areas commonly range from 40 to 100 acres and occupy a greater part of the landscape along the northwest border of these ridges.

A profile description where a substantial part of the original surface layer remains is as follows:

0 to 5 inches, brownish-gray or grayish-yellow cherty silt loam.
5 to 14 inches, light reddish-yellow firm but moderately friable cherty silty clay loam or cherty silty clay.
14 to 40 inches, splotched reddish-yellow, yellow, brown, and gray moderately plastic cherty silty clay. Bedrock dolomitic limestone is at a depth of 10 to 30 feet with occasional small outcrops on the steepest slopes.

The entire profile is moderately to strongly acid. It is low in plant nutrients and infiltration of water is somewhat retarded, but it is permeable to plant roots.

Because of its steep slope and low fertility, this soil is not well suited to crops and under average conditions is probably best used for forest. Its productivity is low, and it is difficult to work and to conserve because of its susceptibility to erosion. However, with proper fertilization and careful management, some areas are capable of affording fair to good pasture.

At sometime all this soil has been tilled, but about 50 percent of it has been abandoned to forest or unimproved pasture. About 10 percent is used for corn, 10 percent for small grains and other crops, and 30 percent for hay and improved pasture. Yields of all crops are low, and most pasture is fair. Areas to be used for pasture should be fertilized, especially with phosphorus and lime, and seeded. Lespedeza and redtop are among the most suitable for seeding pasture, but where the fertility is relatively high, seeding with bluegrass and white clover may be justified. These two plants not uncommonly develop a partial stand in pasture that can be maintained in good condition for a period of years.

Fullerton cherty silty clay loam, severely eroded hilly phase.—As a result of erosion this phase has lost most or all of its original surface layer and in places part of the subsoil. Gullies, 2 to 4 feet deep, though not abundant, are common and in places interfere with field operations. The plow layer varies according to the quantity of erosion. In most places it is reddish-yellow firm cherty silty clay loam or cherty silty clay that is cloddy when tilled. At a depth of 18 to 30 inches the layer is splotched reddish-yellow, yellow, brown, and gray cherty silty clay. In patches there is sufficient cherty silt loam of the original surface layer intermixed with the subsoil material to make the plow layer more yellow and of a more friable consistence.

This soil is medium to strongly acid, low in plant nutrients, and has poor moisture relations for plants. Water is absorbed slowly and little is retained that is available for plants. Much of the soil is lost as runoff, which is difficult to control.

Areas of this phase have been severely eroded during a period of cropping years. Most of these areas are small, a few of them consisting of more than 20 acres. They are widely scattered in the vicinity of Hinds and Copper Ridges.

Poorly suited to crops and only fair for pasture, this soil has low fertility, and its poor moisture relations cause its productivity to be very low; its poor consistence, strong slope, and occasional gullies make it difficult to work; its strong slope, slow absorption, and inability to support a good vegetative cover make it difficult to conserve when tilled.

About 50 percent of this soil has forest reestablished on it or is unimproved pasture land. General farm crops, as corn, wheat, and lespedeza, are the most common crops grown and yields of all are low. If good pasture is to be established, substantial fertilization and liming are necessary, as well as proper seeding. Lespedeza, orchard grass, and redtop are probably among the most suitable plants for this purpose. although as the fertility and physical condition improve, bluegrass and white clover can be included. Some areas can be best used as forest land.

Fullerton cherty silty clay loam, severely eroded steep phase.—This soil represents areas of Fullerton cherty silt loam, steep phase, that have lost most or all of their original surface layer and in places part of the subsoil as a result of erosion. Gullies, 2 to 4 feet deep, are common and in places interfere with field operations. The soil is medium to strongly acid, low in plant nutrients, and has poor moisture relations for plants. Water is absorbed slowly and little is retained that is available for plants. Much of it is lost as runoff and its control as such is very difficult.

The surface layer varies according to the erosion that has taken place. In most places, it is reddish-yellow firm cherty silty clay loam or cherty silty clay that is cloddy when tilled. At a depth of 18 to 30 inches is splotched reddish-yellow, yellow, brown, and gray cherty silty clay. In patches, sufficient cherty silt loam of the original surface layer is intermixed with the subsoil material to make the plow layer more yellow and of a more friable consistence. The aggregate area of this soil is not large. The areas, ranging from 5 to more than 50 acres, are widely scattered throughout the Fullerton-Clarksville-Bolton association.

Poorly suited to crops and pasture, this soil is unproductive because of its low fertility and unfavorable moisture relations. Its workability is poor because of the strong slope and unfavorable consistence, and its conservability is poor because of the strong slope and low moisture-absorbing ability. Unless considerable effort is made to establish a good grass cover by seeding and heavy fertilization, including organic matter, it probably can be used best for forest.

All this soil has been tilled but about 70 percent is now abandoned to forest or unimproved pasture. Most of the rest is used for corn, small grains, and hay or pasture. Yields of all crops are low. Some of the more suitable areas, as the less steep parts and those not subject to runoff water from areas above, may be worth improving for pasture but in general forest cover or such vegetation as kudzu should be established.

Fullerton fine sandy loam.—This type and its several phases form a group of moderately sandy upland soils. They have developed from dolomitic limestone in which there were strata of calcareous fine-grained sandstone. As a group, these Fullerton soils occupy a considerable acreage most of which is south of Richland Knobs.

This type is not extensive, and the separate areas are not large. The surface is undulating to rolling, the gradient ranging to about 12 percent. Most of the areas are on ridge tops and are associated with the more strongly sloping Fullerton, Clarksville, and Bolton soils. Some of the surface drainage is to sinkholes. The native vegetation was predominantly oak, hickory, and tuliptree, with some shortleaf pine intermixed, and other deciduous hardwoods.

A profile description is as follows:

0 to 10 inches, very friable brownish-gray to gray fine sandy loam to loam.

10 to 48 inches, yellowish-red friable but firm and moderately compact when dry fine sandy clay.

48 inches +, splotched yellow, gray, red, and brown crumbly but firm moderately compact when dry fine sandy clay. Bedrock dolomitic limestone is at a depth of 20 to 30 feet.

Dark-brown sandstone or leached arenaceous limestone fragments 2 to 8 inches in diameter are common in many places but do not interfere with cultivation. The entire soil is medium to strongly acid, low in plant nutrients, and moderately friable and permeable to roots and moisture.

This soil is suited to crops requiring tillage. Under good management it is moderately productive, but its natural fertility is low. Because of its undulating to rolling surface and moderately loose consistence, it is easily worked and is not difficult to conserve, although the more sloping parts require some special attention to control runoff. As plant nutrients are rapidly leached from soils as sandy as this type, consistent fertilization is required to maintain a moderately high state of fertility. Although good pastures may be maintained, they are not so productive as are those on the finer textured Fullerton soils.

About a fourth of this soil has been cleared; the rest is under forest. The cleared parts are used principally for wheat, tobacco, corn, and lespedeza. Moderate to light applications of fertilizer are used for corn and for some small grain. Moderately heavy applications are used for tobacco. Lime has been applied to some areas at the rate of about 2 tons an acre. Fall-sown grains are the chief cover crops used and green-manure crops are not commonly grown. Under average management corn yields about 23 bushels, wheat about 10 bushels, and lespedeza about 0.7 ton an acre (pl. 6).

This soil is best managed under a rotation of 3 or 4 years. A sequence of a row crop, 1 or 2 years of small grain, and 1 or 2 years of hay is well suited to it. All the important plant nutrients, nitrogen, phosphorus, and potassium need to be maintained by fertilization and legume crops, and lime is required, especially if legumes as red clover, white clover, or alfalfa are to be grown. Good management requires that organic matter be added either by the application of barnyard manure or green-manure crops. Where a high level of fertility is maintained, red clover, alfalfa, timothy, bluegrass, and white clover can be grown; at lower levels of fertility, lespedeza, redtop, and orchard grass are better suited as hay and pasture crops. Crops respond well to proper fertilization and, when the fertility is maintained at a fairly high level, corn yields about 33 bushels, wheat about 20 bushels, lespedeza

about 1.3 tons, and tobacco about 1,200 pounds an acre. Good returns from tobacco are obtained by supplementing barnyard manure with commercial fertilizer.

Fullerton fine sandy loam, eroded phase.—As a result of erosion this soil differs from the type in having lost 50 to 75 percent of the original surface layer. It is formed from dolomitic limestone in which were strata of calcareous fine-grained sandstone. The subsoil is within plow depth in about a half or more of its area and here tillage has mixed subsoil material with the original surface layer. There are limited tracts where the plow layer is still entirely within the original surface layer and others where all the original surface layer has been lost and the plow layer now consists entirely of subsoil material. The surface is rolling (about 12 percent), and drainage is good.

This phase is widely distributed south of Richland Knobs. Areas seldom exceed 40 or 50 acres, and most of them occupy ridge crests associated chiefly with hilly phases of Fullerton soils.

A profile description is as follows:

0 to 5 inches, brownish-gray or grayish-yellow fine sandy loam or loam. The thickness of this layer varies greatly depending on the quantity of erosion.

5 to 40 inches, yellowish-red friable but firm moderately compact when dry fine sandy clay.

40 inches +, splotched yellow, gray, red, and brown crumbly but firm moderately compact when dry fine sandy clay. Bedrock dolomitic limestone is at a depth of 20 to 30 feet.

Dark-brown sandstone or leached sandy limestone fragments 2 to 8 inches in diameter are common in many places but are not sufficiently abundant to interfere with cultivation. The entire soil is medium to strongly acid and low in plant nutrients. It is moderately friable and permeable to roots and moisture.

This soil is suited to crops requiring tillage. Under good management it is moderately productive, but its natural fertility is low. Because of its undulating to rolling surface and moderately loose consistence, the soil is easily worked and is not difficult to conserve, although the more sloping parts require some special attention to control runoff. Consistent fertilization is required to maintain a moderately high state of fertility, as plant nutrients are rapidly leached off.

All this soil has been cleared and cropped. About 35 percent of it is used for corn, 30 percent for wheat, 25 percent for hay and pasture, and a small part for tobacco and other crops. Moderate to light applications of fertilizer are used for corn and for small grain. Moderately heavy applications are used for tobacco. Lime has been applied to some areas at the rate of about 2 tons an acre. Fall-sown grains are the chief cover crops used and green-manure crops are not commonly grown. Under average management corn yields 20 to 25 bushels, wheat about 10 bushels, and lespedeza about 0.6 ton an acre.

Rotations consisting of 1 year of row crops, 1 or 2 years of small grain, and 1 or 2 years of legume hay or pasture, are well suited to this soil providing its fertility is maintained at a fairly high level and other practices are used to conserve it from losses by runoff. All the important plant nutrients—nitrogen, phosphorus, and potassium—need to be

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maintained by fertilization, and lime is required, especially if legumes, as red clover, white clover, or alfalfa are grown. Where the fertility is not maintained at a high level, lespedeza, redtop, and orchard grass are better suited as hay and pasture crops. Crops respond well to proper fertilization and when the fertility is maintained at a fairly high level under good management, corn yields about 33 bushels, wheat about 18 bushels, lespedeza about 1.3 tons, and tobacco about 1,100 pounds an acre. Good returns from tobacco are obtained by supplementing barnyard manure with commercial fertilizer.

Proper conservation requires that tillage be kept at a minimum and a vegetative cover be maintained on it as much of the time as possible. Cover crops should follow row crops in order to protect the soil in winter, and tillage should be on the contour wherever feasible. Terracing may be practical under certain conditions as a means of erosion control.

Fullerton fine sandy loam, undulating phase.—This soil differs from the type in having a smoother surface, the gradient ranging to about 5 percent. It is developed from dolomitic limestone in which were strata of calcareous fine-grained sandstone. Drainage is good. Practically all the soil occupies small areas on the ridge tops. The separate areas are widely distributed in the area south of Richland Knobs.

A profile description is as follows:

0 to 14 inches, brownish-gray to gray friable fine sandy loam or loam.

14 to 48 inches, yellowish-red friable but firm moderately compact when dry fine sandy clay.

48 inches +, splotched yellow, gray, red, and brown crumbly but firm and moderately compact when dry sandy clay. Bedrock dolomitic limestone is at a depth of 20 to 30 feet.

Dark-brown sandstone or leached sandy limestone fragments, 2 to 8 inches in diameter, are common in many places but are not sufficiently abundant to interfere with cultivation. The entire profile is medium to strongly acid, low in plant nutrients, moderately friable, and permeable to roots and moisture.

A small acreage has some chert throughout its depth, and these more sloping areas tilled for many years have lost 50 to 75 percent of the surface layer. The plow layer consists of a mixture of surface and subsoil material.

This soil is suited to crops requiring tillage. Under good management it is moderately productive, but its natural fertility is low. It is easily worked and not difficult to conserve, although consistent fertilization is necessary in maintaining a moderately high state of fertility as plant nutrients are rapidly leached.

All this soil has been cleared and cropped. About 40 percent of it is used for corn, 30 percent for hay and pasture, and 30 percent for wheat, tobacco, and other crops. Moderate to light applications of fertilizer are used for corn and for some small grain. Moderately heavy applications are used for tobacco. Lime has been applied to some areas at the rate of about 2 tons an acre. Fall-sown grains are the principal cover crops used, and green-manure crops are not commonly grown. Under average management corn yields about 25 bushels, wheat

about 11 bushels, and lespedeza about 0.7 ton an acre.

This soil is suited to a moderately short rotation providing the fertility is maintained at a relatively high level. If a high productivity is to be maintained, all the important plant nutrients—nitrogen, phosphorus, and potassium—need to be maintained by consistent fertilization and legume crops. Organic matter must be added either as manure or through green-manure crops, and lime is required especially for red and white clovers and alfalfa. Unless a relatively high state of fertility is maintained, lespedeza, redtop, and orchard grass are preferred for hay and pasture crops. Where the productivity of the soil is maintained at a high level, corn yields about 38 bushels, wheat about 19 bushels, red clover about 1.6 tons, and tobacco about 1,300 pounds an acre.

Fullerton fine sandy loam, hilly phase.—This soil differs from the type in having a stronger slope (12 to 30 percent). It is developed from dolomitic limestone in which were strata of calcareous fine-grained sandstone. Drainage is good. Most areas have a complex slope or lay of the land condition consisting of narrow ridge tops and strong slopes extending to drainageways and sinkholes. Native vegetation consisted chiefly of oak, hickory, and tuliptree, with some pine intermixed. The area occupied by this phase is not large, and it occurs south of Richland Knobs.

A profile description is as follows:

0 to 12 inches, brownish-gray to gray friable fine sandy loam. This layer varies in thickness.

12 to 42 inches, yellowish-red friable but firm and moderately compact when dry fine sandy clay.

42 inches +, splotched yellow, gray, red, and brown crumbly but firm moderately compact when dry fine sandy clay. Bedrock is at a depth of 20 to 30 feet.

Dark-brown sandstone or leached sandy limestone fragments 2 to 8 inches in diameter are common but do not interfere with cultivation. The entire soil is medium to strongly acid, low in plant nutrients, moderately friable, and permeable to roots and moisture.

Although limited by its strong slope and low fertility, this soil is suited to crops requiring tillage, as small grains and certain hay and pasture crops. Also because of its strong slope, it is difficult to work and, under a system of management involving cultivation, it is difficult to conserve satisfactorily.

Practically none of this soil has been tilled, and at present it is occupied chiefly by cut-over deciduous forest. Cleared areas produce fair to good yields for a few years, but if good yields are to be maintained, regular fertilization and liming must be practiced, organic matter maintained, and management otherwise adjusted to keep the soil losses by erosion at a minimum. A rotation of fall-sown small grains with a hay or pasture crop is well suited. If the fertility is maintained at a high level, red clover, timothy, or alfalfa may be grown, otherwise, lespedeza and redtop are the preferred hay and pasture plants. Where properly fertilized and otherwise well managed, lespedeza yields 1 to 1.2 tons, wheat 13 bushels, and barley about 22 bushels an acre. If row crops are required, they should be grown very infrequently and should be

followed by a cover crop. Field operations, especially plowing and cultivation, should be on the contour and where row crops are grown, strip cropping may be advisable. Terracing is not considered practical except on some of the smoothest parts.

Fullerton fine sandy loam, severely eroded hilly phase.—This soil represents areas of the hilly phase of the type that have lost practically all their surface soil and in places part of their subsoil by erosion. It is formed from dolomitic limestone in which were strata of calcareous fine-grained sandstone. Drainage is good. The surface is strongly sloping (12 to 30 percent).

In most areas that are not tilled gully erosion has been sufficiently active to cause the surface to be uneven, and there may be a few gullies that are not obliterated by tillage. Most of these, however, are crossable with farm machinery. Areas idle for several years commonly have gullies and a few of these are difficult or impossible to cross. The larger gullies are shown on the soil map by appropriate symbols. The separate areas are small and are generally part of a hilly landscape consisting of Bolton and other less eroded Fullerton soils. All is in the area south of Richland Knobs. The native vegetation consisted of oak, hickory, and tuliptree, with some pine intermixed.

A profile description is as follows:

0 to 30 inches, yellowish-red friable but firm and moderately compact when dry fine sandy clay.

30 inches +, splotched yellow, gray, red, and brown crumbly but firm moderately compact when dry fine sandy clay. Bedrock is at a depth of 20 to 30 feet.

Dark-brown sandstone or leached sandy limestone fragments, 2 to 8 inches in diameter, are common but not sufficiently abundant to interfere with cultivation. The entire soil is medium to strongly acid and low in plant nutrients. The plow layer is much less friable than that of the less eroded phases, and its capacity to hold moisture available to plants is much lower. On the whole the soil is moderately permeable to roots and slowly permeable to moisture.

The productivity is very low, because of its low fertility and droughty nature. Its strong slope and unfavorable consistence make it difficult to work and difficult to conserve when tilled. It is therefore not well suited to crops but if properly fertilized and managed, it is suitable for pasture. Many areas may be best used for forest.

All this soil has been cleared and cropped, but about 50 percent of it has been abandoned to forest or unimproved pasture. About 15 percent is used for corn, 25 percent for hay and pasture, chiefly lespedeza, and 10 percent for small grain and other crops. Pasture on the abandoned areas is poor. Most of the cover of such areas consists of an uneven stand of broomsedge with some sassafras, persimmon, and briers intermixed. Only irregular, light applications of fertilizer are made and most of this is for wheat. Very little manure is applied and crops are not commonly plowed under to increase the fertility. Lime has been applied to some areas. Rotations are not consistently followed, but it is a common practice to allow areas to lie idle for a period of years, after which they are again cropped for a short time. Under average

management, corn yields about 10 bushels, wheat about 4 bushels, and lespedeza about 0.4 ton an acre.

Most areas can be best used as permanent pasture. For this purpose, the fertility and physical nature of the soil should be improved sufficiently to support a good legume and grass cover. Phosphorus, lime, and organic matter are especially needed for this purpose, but nitrogen and potassium are also low, and applications of them can be expected to give response in the crops. Except where the fertility is greatly increased, lespedeza, redtop, and orchard grass are among the most suitable pasture plants. Weed and brushy growth will require eradication on most areas, if good pasture is to be maintained.

Fullerton fine sandy loam, eroded hilly phase.—As a result of erosion this soil represents areas of the typical hilly phase that have lost 50 to 75 percent of the surface soil. It is developed from dolomitic limestone in which were strata of calcareous fine-grained sandstone. Drainage is good. The surface is hilly (12 to 30 percent). Most areas have a complex slope or lay of the land condition consisting of narrow ridge tops and strong slopes extending to drainageways and sinkholes. The native vegetation consisted of oak, hickory, and tuliptree, with some pine intermixed. Separate areas of this fairly extensive soil are about 50 acres in size and are widely scattered south of Richland Knobs.

A profile description is as follows:

0 to 5 inches, brownish-gray or grayish-yellow fine sandy loam or loam. Where erosion has been less than average the surface layer may be 10 to 12 inches thick, whereas in the most eroded patches the subsoil may be exposed.

5 to 40 inches, yellowish-red friable but firm moderately compact when dry fine sandy clay.

40 inches +, yellow, gray, red, and brown crumbly but moderately firm and compact when dry fine sandy clay.

Dark-brown sandstone or leached sandy limestone fragments 2 to 8 inches in diameter are common in many places but do not interfere with cultivation. The entire soil is medium to strongly acid, low in plant nutrients, and moderately friable and permeable to roots and moisture.

The soil is physically suited to crops requiring tillage, although it is limited by its strong slope and low fertility. Under proper management, it is suited to small grains and certain hay and pasture crops. Because of its strong slope, it is difficult to work and under a system of management involving cultivation, it is difficult to conserve satisfactorily.

All this soil has been cleared and cropped but about 10 percent of it has been abandoned to forest or unimproved pasture. About 20 percent is used for corn, 20 percent for wheat, 5 percent for tobacco, and about 45 percent for hay and pasture in rotation. Fertilization is heavy for tobacco, but other crops receive only irregular light applications of commercial fertilizer. Lime has been applied to some of this soil at about 2 tons an acre. Little organic matter is returned to the soil and fall-sown small grains are the chief cover crops. Much land used for corn is without an effective cover in winter. Under average management, corn yields about 15 bushels, wheat 8 bushels, and lespedeza, 0.4 ton an acre. Relatively long rotations should be used and cover crops,

preferably legumes, should be grown where the surface would otherwise be without a growing vegetative cover. In general, crops respond to fertilization with nitrogen, phosphorus, and potassium. Organic matter, either as barnyard manure or green-manure crops, should be added at regular intervals, and lime is required for good yields of legumes and grasses. Where properly seeded and grazed, pastures respond to phosphorus and lime.

Tillage should be kept at a minimum because of the erosion hazard. Permanent meadow and pasture are well suited to this phase. Tillage and other field operations should be on the contour, and strip cropping may be advisable.

Fullerton cherty fine sandy loam.—A light-colored cherty fine sandy loam soil with a thick cherty yellowish-red subsoil on some of the cherty ridges, developed from cherty dolomitic limestone in which were strata of calcareous fine-grained sandstone. It differs from Fullerton cherty silt loam chiefly in having a more sandy texture. It is well drained, some of it to sinkholes, and the surface is rolling (about 12 percent). Most areas are on ridge crests associated with the more strongly sloping Fullerton, Bolton, and Clarksville soils. The native vegetation was chiefly oak, hickory, and tuliptree, with some pine intermixed. Most areas are inextensive and widely distributed south of Richland Knobs.

A profile description is as follows:

0 to 14 inches, friable brownish-gray to gray cherty fine sandy loam or cherty loam.

14 to 48 inches, yellowish-red friable but firm and moderately compact when dry cherty fine sandy clay.

48 inches +, splotched yellow, gray, red, and brown crumbly but firm moderately compact when dry cherty fine sandy clay. Bedrock dolomitic limestone is at a depth of 20 to 30 feet.

Dark-brown sandstone or leached sandy limestone fragments 2 to 8 inches in diameter are common. In most places these fragments with the chert are sufficiently abundant to interfere materially with cultivation. The entire soil is medium to strongly acid and low in plant nutrients and organic matter. The surface layer is friable, and the subsoil is moderately permeable to roots and moisture.

This soil is suited to crops requiring tillage, but its productivity is low and the high content of chert and stone fragments makes it moderately difficult to work, especially with hand implements. A high state of fertility is probably difficult to maintain because of the ease with which plant nutrients are lost by leaching and runoff water. Erosion is active on the more sloping parts when a good vegetative cover is not maintained.

About 25 percent of the soil has been cleared and used for corn, small grains, chiefly wheat, and hay. Lespedeza is the principal hay crop. Fertilization is moderate to light and irregular, and green-manure crops are not commonly grown. Row crops, chiefly corn, are grown at frequent intervals. Some lime probably has been applied to a few areas. Under average management corn yields about 15 bushels, wheat 8 bushels, and lespedeza about ½ ton an acre. The soil responds to good management. Substantial fertilization especially with phosphorus,

lime, and probably potassium and an increase in the content of organic matter are necessary for good yields.

The soil should be protected as much of the time as possible by a close-growing crop and for this purpose, moderately long rotations consisting chiefly of fall-sown small grains and legumes and grass hay and pasture crops are suitable. Where the fertility is increased red clover, timothy, and possibly alfalfa are suitable, but in general lespedeza, redtop, and orchard grass are among the better suited hay and pasture crops. Tillage and other field operations should be on the contour where feasible and terracing may be practical at least where tillage is carried on regularly. Under good management, corn yields about 25 bushels, wheat about 15 bushels, and lespedeza about 0.8 ton an acre.

Fullerton cherty fine sandy loam, eroded phase.—As a result of erosion this soil represents areas of the type that have lost 50 to 75 percent of the surface layer. It is developed from cherty dolomitic limestone in which were strata of calcareous fine-grained sandstone. Drainage is good. The surface is rolling (about 12 percent). Most areas are on ridge tops associated with the more strongly sloping Fullerton, Bolton, and Clarksville soils south of Richland Knobs. Separate areas seldom occupy more than 40 to 50 acres. The native vegetation was chiefly oak, hickory, and tuliptree, with some pine intermixed.

A profile description is as follows:

0 to 5 inches, brownish-gray or grayish-yellow cherty fine sandy loam or cherty loam. The thickness varies greatly, depending on the quantity of erosion.

5 to 40 inches, yellowish-red friable but firm moderately compact when dry cherty fine sandy clay.

40 inches +, splotched yellow, gray, red, and brown crumbly but firm moderately compact when dry cherty fine sandy clay. Bedrock cherty dolomitic limestone is at a depth of 20 to 30 feet.

Dark-brown sandstone or leached sandy limestone fragments 2 to 8 inches in diameter are common. These fragments with the chert are sufficiently abundant in most places to interfere materially with cultivation. The entire soil is medium to strongly acid and low in plant nutrients and organic matter. The surface layer is friable, and the subsoil is moderately permeable to roots and moisture.

This phase is suitable for crops requiring tillage, but its low fertility causes its productivity to be low, and the high content of chert and stone fragments makes it difficult to work, especially with hand implements. Erosion is active on the more sloping parts, especially cultivated areas, where a good vegetative cover is not maintained.

All the soil has been cleared and most of it is cropped. About 25 percent is used for hay and pasture, about 30 percent for wheat, and about 40 percent for corn, tobacco, and other crops. Very little is idle. Lespedeza is the principal hay crop and wheat the chief small grain. Fertilization is moderate to light and irregular, and green-manure crops are not commonly grown. Some lime has been applied. Row crops, chiefly corn, are grown at frequent intervals on much of the acreage. Fall-sown small grains and hay and pasture crops afford an effective

cover on some of the acreage but much of it is not protected by a growing crop through the winter.

Under average management, corn yields about 12 bushels, wheat about 7 bushels, and lespedeza about 0.4 ton an acre. Substantial fertilization, especially with phosphorus and lime and probably potassium, and an increase in the content of organic matter are necessary for good yields. The soil should be protected as much of the time as possible by a close-growing crop and for this purpose moderately long rotations, consisting chiefly of fall-sown small grains and legume and grass hay and pasture crops, are suitable. Where the fertility is greatly increased and sufficient lime is applied, red clover, timothy, white clover, bluegrass, and possibly alfalfa are suitable but in general, lespedeza, redtop, and orchard grass are among the better suited hay and pasture crops. Tillage and other field operations should be on the contour where feasible, and terracing may be practical where tillage is carried on regularly. Under good management, corn yields about 22 bushels, wheat about 15 bushels, and lespedeza about 0.7 ton an acre.

Fullerton cherty fine sandy loam, hilly phase.—This soil, developed from cherty dolomitic limestone in which were strata of calcareous fine-grained sandstone, differs from the type in having a more strongly sloping surface (12 to 30 percent). Drainage is good. Most areas have a complex slope or lay of the land consisting of narrow ridge tops and strong slopes that extend to drainways and sinkholes. The separate areas range from a few to 50 acres or more and are widely distributed in the area south of Richland Knobs. The native vegetation was predominantly oak, hickory, and tuliptree, with some pine intermixed.

A profile description is as follows:

0 to 12 inches, friable brownish-gray to gray cherty fine sandy loam or cherty loam. This layer varies greatly in thickness.

12 to 42 inches, yellowish-red friable but firm moderately compact when dry cherty fine sandy clay.

42 inches +, splotched yellow, gray, red, and brown crumbly but firm moderately compact when dry cherty fine sandy clay. Bedrock is at a depth of 20 to 30 feet.

Dark-brown sandstone or leached sandy limestone fragments 2 to 8 inches in diameter are common. These fragments with the chert are sufficiently abundant to interfere materially with cultivation. The entire soil is medium to strongly acid and low in plant nutrients and organic matter. The surface layer is friable, and the subsoil is permeable to roots and moisture.

Although limited by its strong slope, low fertility, and stoniness this soil is physically suited to crops requiring tillage. Under proper management, it is suited to a rotation of fall-sown small grains and certain hay and pasture crops. Because of its strong slope and stoniness, it is difficult to work and under a system of management involving cultivation, it is difficult to conserve satisfactorily.

Practically none of this soil has been tilled and at the present time, it is occupied chiefly by a cut-over deciduous forest. When cropped, it can be expected to produce fair fields for a very few years, but if good yields are to be maintained, regular fertilization and liming must be practiced, the organic matter maintained, and the management other-

wise adjusted to keep losses by erosion at a minimum. A rotation of fall-sown small grains with a hay or pasture crop is well suited to this phase. If it is necessary to grow row crops, they should be grown very infrequently and followed by a cover crop. Field operations, especially plowing and cultivation, should be on the contour and when row crops are grown, strip cropping may be advisable. Terracing is not considered practical except possibly on some of the smoother parts. Under proper fertilization and management, lespedeza yields about 0.9 ton and wheat about 12 bushels an acre.

Fullerton cherty fine sandy loam, eroded hilly phase.—A soil formed from cherty dolomitic limestone in which were strata of calcareous fine-grained sandstone. It differs from type in having a stronger slope and in having lost 50 to 75 percent of its surface layer by erosion. Drainage is good. The surface is hilly (12 to 30 percent). Most areas have a complex slope or lay of the land consisting of narrow ridge tops and strong slopes extending to drainways and sinkholes. This is one of the more extensive of the Fullerton soils. The separate areas are of moderate size and are widely distributed south of Richland Knobs. The native vegetation was predominantly oak, hickory, and tuliptree, with some pine intermixed.

A profile description is as follows:

0 to 5 inches, brownish-gray or grayish-yellow cherty fine sandy loam or cherty loam. Where there has been less than the average quantity of erosion, the thickness of this layer may be 10 to 12 inches, whereas in the most eroded patches subsoil material may be exposed.

5 to 40 inches, yellowish-red friable but firm moderately compact when dry cherty fine sandy clay.

40 inches +, yellow, gray, red, and brown crumbly but moderately firm and compact when dry cherty fine sandy clay. Bedrock dolomitic limestone is at a depth of 20 to 30 feet.

Dark-brown sandstone or leached sandy limestone fragments 2 to 8 inches in diameter are common in many places, and these fragments with the chert are sufficiently abundant in most places to interfere materially with cultivation. The entire soil is medium to strongly acid and low in plant nutrients and organic matter. The surface layer is friable, and the subsoil is moderately permeable to roots and moisture.

This soil is physically suited to crops requiring tillage although it is limited in this respect by its strong slope, low fertility, and stoniness. Under proper management, it is suited to a rotation of fall-sown small grains and certain hay and pasture crops. Because of its strong slope and stoniness, it is difficult to work, and under a system of management involving cultivation, it is difficult to conserve satisfactorily.

All this soil has been cleared and cropped, but about 20 percent is now abandoned to forest or unimproved pasture. About 15 percent is used for corn, 15 percent for small grains, 45 percent for hay and improved pasture, and the rest for miscellaneous crops including some tobacco. Fertilization is light and irregular except on the land for tobacco. Wheat commonly receives light applications, but hay crops are seldom fertilized, although lime has been applied on some acreage and some phosphorus has been used for hay. Little organic matter is re-

turned to the soil, and fall-sown small grains and the hay crops are the only winter cover crops. Under average management, corn yields about 10 bushels, wheat about 6 bushels, and lespedeza about 0.4 ton an acre.

Crops are not commonly rotated systematically. If crops are to be grown, a relatively long rotation should be used and cover crops, preferably legumes, should be grown where the surface would otherwise be without a growing vegetative cover. A rotation consisting entirely of fall-sown small grains and hay and pasture legumes and grains is well suited to this soil. Substantial fertilization, liming, and incorporation of organic matter are required if good yields are to be obtained. Legumes and grasses respond well to phosphorus and lime, but unless the fertility of the soil is brought to a high level, lespedeza, redtop, and orchard grass are generally more suitable than red clover, white clover, timothy, and bluegrass. Under proper fertilization and management, lespedeza yields about 0.9 ton an acre.

Tillage should be kept at a minimum, because of the erosion hazard. Where feasible, permanent pasture and meadow are preferred for this phase. Tillage and other field operations should be on the contour and strip cropping may be advisable.

Included with this soil are a few areas that have a subsoil more like that of the Clarksville soils inasmuch as the material is yellow rather than yellowish-red cherty clay loam.

Fullerton cherty clay loam, severely eroded phase.—This soil represents areas of Fullerton cherty fine sandy loam that have lost practically all the surface soil as a result of erosion. It is developed from cherty dolomitic limestone in which were strata of calcareous fine-grained sandstone. The surface is sloping or rolling, and the gradient ranges to about 12 percent. Drainage is good. In most tilled areas gully erosion has been sufficiently active to cause the surface to be uneven, and there may be a few gullies that are not obliterated by tillage, but most of them are crossable with farm machinery. On areas that have been idle for several years a few gullies have formed that are difficult or impossible to cross. The larger ones are shown on the soil map by appropriate symbols.

Most areas are on the upper part of ridge slopes associated with the less eroded areas of Fullerton cherty fine sandy loam. The small areas are widely scattered south of Richland Knobs. The native vegetation was chiefly oak, hickory, and tuliptree, with some pines intermixed.

A profile description is as follows:

0 to 30 inches, yellowish-red firm and moderately compact when dry cherty fine sandy clay.

30 inches +, splotched yellow, gray, red, and brown crumbly but firm moderately compact when dry cherty fine sandy clay. Bedrock is at a depth of 20 to 30 feet.

Dark-brown sandstone or leached sandy limestone fragments 2 to 8 inches in diameter are common. In most places these fragments with chert are sufficiently abundant to interfere materially with cultivation. The entire soil is medium to strongly acid and low in plant nutrients and organic matter. The surface layer is friable, and the subsoil is moderately permeable to roots and moisture.

Because of its low fertility, unfavorable consistence of the plow layer, stoniness, and low capacity for water available to plants, this soil is not well suited to crops requiring tillage. Unless its productivity is greatly increased, yields are low and erosion is active. If it is improved sufficiently to support a good grazing cover, it is suited to pasture.

All this soil has been cleared and cropped, but approximately 20 percent of it has been abandoned to forest or unimproved pasture. About 30 percent is used for corn, 20 percent for small grains, principally wheat, and about 30 percent for hay and improved pasture. Little fertilization is practiced, and cover crops other than the fall-sown grains are not commonly used. It is a common practice to allow areas of this soil to lie idle for several years between periods of cropping. Under average conditions corn yields about 10 bushels, wheat 4 bushels, and lespedeza 0.4 ton an acre. Fairly good pasture can be established but in order to do so, the organic-matter, plant-nutrient, and lime content must be greatly increased. Lespedeza, redtop, and orchard grass are among the hay and pasture plants best suited to this type. Areas that must be cropped should be used in a rotation of close-growing fall-sown small grains and legume and grass hay and pasture crops.

Included with this soil are a few areas free of chert, which represent severely eroded areas of Fullerton fine sandy loam.

Fullerton cherty clay loam, severely eroded hilly phase.—This soil differs from Fullerton cherty fine sandy loam in having a stronger slope and in having lost practically all the surface soil by erosion. It is developed from cherty dolomitic limestone in which were strata of calcareous sandstone. Drainage is good. Surface drainage is partly to drainways and partly to sinkholes. The surface is strongly sloping (12 to 30 percent). In most areas now tilled gully erosion has been sufficiently active to cause the surface to be uneven, and there may be a few gullies that are not obliterated by tillage, but most of them are crossable with farm machinery. Areas that have been idle for several years commonly have gullies and a few of these are difficult or impossible to cross. The large gullies are shown on the soil map by appropriate symbols. The areas are relatively small and are associated with other Fullerton and Bolton soils south of Richland Knobs. The native vegetation was oak, hickory, and tuliptree, with some pine intermixed.

A profile description is as follows:

0 to 30 inches, yellowish-red friable but firm and moderately compact when dry fine sandy clay.

30 inches +, splotched yellow, gray, red, and brown crumbly but firm moderately compact when dry fine sandy clay. Bedrock is at a depth of 20 to 30 feet.

Dark-brown sandstone or leached sandy limestone fragments 2 to 8 inches in diameter are common, and with the chert, they are sufficiently abundant to interfere with tillage. The entire soil is medium to strongly acid and low in plant nutrients and organic matter. The surface layer is less friable than that of the less eroded phases, and its capacity to hold moisture available to plants is much lower. On the whole the soil is moderately permeable to roots and slowly permeable to moisture.

Because of the low fertility and droughty nature of this phase, the productivity is very low. Its strong slope and unfavorable consistence

make it difficult to work, and it is difficult to conserve when tilled. It is therefore not well suited to crops but if properly fertilized and managed, it is suitable for pasture. Many areas may be best used for forest.

All this soil has been cleared and cropped but about 50 percent of it has been abandoned to forest or unimproved pasture. About 15 percent is used for corn, 25 percent for hay and pasture, chiefly lespedeza, and 10 percent for small grains and other crops. Pasture on the abandoned areas is poor. Most of the cover consists of an uneven stand of broomsedge with some sassafras, persimmon, and briers intermixed. Only light and irregular applications of fertilizer are made and most of this is for wheat. Very little manure is used and crops are not commonly plowed under as green manure. Lime has been applied to a small acreage. Rotations are not consistently followed, but it is a common practice to allow areas to lie idle for a period of years after which they are again cropped for a short time. Under average management, corn yields about 8 bushels, wheat 4 bushels, and lespedeza about 0.3 ton an acre. Most areas probably can be best used as permanent pasture. For this purpose the fertility and physical nature should be improved sufficiently to support a good legume and grass cover. Phosphorus, lime, and organic matter are especially needed for this purpose, but nitrogen and potassium are also low and applications of them can be expected to give response in the crops. Except where the fertility is increased greatly, lespedeza, redtop, and orchard grass are among the most suitable pasture and hay plants. If good pasture is to be maintained, weeds and brushy growth will have to be eradicated on most areas.

Greendale loam.—This light-brown soil on gentle valley slopes consists of local alluvium or colluvium washed from Fullerton and Clarksville soils. The surface is gently sloping, the gradient ranging up to about 5 percent. Internal drainage is somewhat retarded but is sufficiently good for all crops commonly grown. All the areas are small. Most of them are on alluvial fans at the mouths of short drains from areas of Fullerton and Clarksville soils, but a few lie as gently sloping narrow strips at the base of the hills. The areas are widely scattered near Hinds and Copper Ridges and south of Richland Knobs. The native vegetation was predominantly deciduous hardwoods.

A profile description of this loam is as follows:

0 to 10 inches, brownish-gray to grayish-brown friable loam.
10 to 30 inches, brownish-yellow firm but friable silty clay loam that breaks to nut-sized fragments.
30 inches +, yellow mottled with gray and brown friable silty clay loam.

The texture of the surface layer varies from loam to silt loam, the latter prevailing in those areas associated with silt loam of the Fullerton and cherty silt loam types of the Fullerton and Clarksville soils. Those areas associated with the more cherty Clarksville and Fullerton soils have some chert and in a few places it is sufficiently abundant to interfere a little with tillage. The subsoil varies in structure. Whereas most areas have a fairly well developed subsoil, some areas consist of silt loam with little structure throughout and do not have so strong a color contrast between the surface layer and the subsoil.

The entire profile is medium to strongly acid. It is moderately fertile, moderately low in content of organic matter, permeable to roots and moisture, and its capacity for holding moisture available to plants is fairly good.

This loam is well suited to crops requiring tillage and to all crops commonly grown in the county. It is moderately productive, responds to fertilization, is easily worked, and is not difficult to conserve either against losses by runoff or leaching.

Practically all of this soil is cleared and cropped. Corn occupies about 45 percent, tobacco about 10 percent, hay and pasture about 25 percent, and small grains about 20 percent. Short rotations are common, and row crops are grown on the average of 1 year out of 2, whereas some areas are used almost continuously for this purpose. Some fertilization is practiced, and those areas near the farm buildings generally receive manure. Lime has been applied to a fairly large part; most of it at about 2 tons an acre. The tobacco crop is fertilized heavily with barnyard manure supplemented by commercial fertilizer. Under average management, corn yields about 28 bushels, barley 16 bushels, red clover 1 to 1.5 tons, and tobacco about 1,000 pounds an acre. Tobacco ordinarily is of good quality. The productivity of this soil can be increased materially by heavier fertilization, systematic liming, and the addition of organic matter. It is suited to moderately short rotations, but the row crops should be followed by cover crops to aid in maintaining its fertility and favorable tilth and to protect it from erosion. Where the fertility is maintained at a high level, crimson clover is one of the better cover crops and red clover one of the better hay crops. Pasture mixtures, including bluegrass and white clover, afford good grazing, where the fertility and lime requirements have been fulfilled. The more sloping parts and those subject to runoff may require special attention to avoid damage by runoff. Under a high level of management, corn yields about 40 bushels, barley 32 bushels, and red clover or lespedeza 1½ to 2 tons an acre.

Greendale loam, sloping phase.—Differing from the type, this phase has a more sloping surface (5 to 15 percent). It is developed on local alluvium or colluvium washed chiefly from Fullerton and Clarksville soils. Internal drainage is somewhat retarded but is sufficient for all crops commonly grown. Few areas include more than 15 acres. Most areas are at the heads of drains and on alluvial fans at the mouths of short drains from areas of Fullerton and Clarksville soils. They are widely distributed in association with Fullerton, Clarksville, and Bolton soils. Native vegetation was predominantly deciduous hardwoods.

A profile description is as follows:

0 to 8 inches, brownish-gray or grayish-brown friable loam.
8 to 30 inches, brownish-yellow firm but friable silty clay loam that breaks to nut-sized fragments.
30 inches +, yellow mottled with gray and brown friable silty clay loam.

The thickness of the surface layer ranges from 4 to 12 inches. Part of the shallower thickness is due to erosion. The texture of this layer varies from loam to silt loam, the latter prevailing in those areas associated with the silt loam of the Fullerton and cherty silt loam types of

the Fullerton and Clarksville soils. Areas associated with these more cherty soils have some chert and in places, it is sufficiently abundant to interfere with cultivation.

The entire profile is medium to strongly acid. The soil is moderately fertile, its content of organic matter is moderately low, it is permeable to roots and moisture, and its capacity to hold moisture available to plants is fairly good.

This soil is suited to crops requiring tillage. It is moderately productive, but because of its stronger slope, it is a little more difficult to work and is more subject to soil losses by runoff than is the type. In general its proper management requires a longer rotation and fewer row crops.

Practically all this soil is cleared and cropped. Approximately 30 percent is used for corn, 10 percent for tobacco, 40 percent for hay and pasture, and 20 percent for small grains. Length of rotations varies from 3 to 5 years. Some fertilization is practiced, and those areas near the farm buildings generally receive barnyard manure. Lime has been applied to some areas. The tobacco crop is fertilized heavily with barnyard manure supplemented by commercial fertilizer. Under average management, corn yields about 22 bushels, barley 12 bushels, and lespedeza about ¾ ton an acre. Tobacco ordinarily is of good quality. The productivity of this soil can be increased materially by heavier fertilization, systematic liming, and the addition of organic matter. Because of its susceptibility to erosion, row crops should not be grown frequently and cover crops should be used where the surface would otherwise be bare in winter. Where the fertility is maintained at a relatively high level, crimson clover and red and white clovers are well suited and lespedeza, white clover, orchard grass, and bluegrass produce good quality grazing. Where feasible, cultivation should be on the contour, and strip cropping and terracing are practical.

Greendale silty clay loam.—This type consists of local alluvium and colluvium washed from soils developed over clayey or argillaceous limestone. Internal drainage is slow, and the surface is gently sloping (about 5 percent). All the areas are small, and most of them are in Clinch Valley. Most of them are along the upper parts of drainageways. The native vegetation was predominantly deciduous hardwoods.

A profile description is as follows:

0 to 8 inches, grayish-brown mellow silty clay loam.
8 to 22 inches, yellow plastic silty clay loam or silty clay.
22 inches +, mottled yellow, gray, brown, and red tough plastic silty clay.

This soil is slightly to medium acid, is moderately fertile, and has a fair quantity of organic matter. The surface soil has fairly good tilth, and the subsoil is slowly permeable to roots and moisture. The soil has a fairly good capacity for holding water available to plants.

Although not well suited to tobacco and root crops, as potatoes, this type is suited to crops requiring tillage. It is naturally moderately productive and bluegrass and white clover do well on many areas without special treatment. Its workability is impaired some by the heavy consistence and rather slow internal drainage. Only the most sloping parts present any material conservation problems.

Practically all this soil is being used for crops and pasture. About 60 percent is used for hay and pasture, 25 percent for corn, and most of the rest for small grains. Little fertilization is practiced and not much lime has been used. Lengths of rotations vary greatly. A few areas are used consistently for row crops, whereas some of the less accessible areas are used mostly for pasture. Cover crops are not commonly grown, and not much organic matter is returned to the soil either by barnyard manure or green-manure crops. Under average management, corn yields about 28 bushels, wheat 14 bushels, and lespedeza about 1 ton an acre. Pasture is of good quality and has a fairly high carrying capacity. Heavier fertilization, the addition of organic matter, and in places, applications of lime may increase yields materially.

Greendale silty clay loam, sloping phase.—This soil differs from the type in having a more sloping surface (5 to 15 percent). It is developed from local alluvium and colluvium washed from soils developed over clayey or argillaceous limestone. Internal drainage is slow. All the areas are small, and most of them are along the upper parts of drainageways. The native vegetation was deciduous hardwoods.

A profile description is as follows:

0 to 8 inches, grayish-brown mellow silty clay loam.
8 to 22 inches, yellow plastic silty clay loam or silty clay.
22 inches +, mottled yellow, gray, brown, and red tough plastic silty clay.

In places where erosion has been active the surface layer is thinner; occasionally, the subsoil is exposed. The soil is slightly to medium acid, is moderately fertile, and has a fair quantity of organic matter. The surface soil has fairly good tilth, and the subsoil is slowly permeable to roots and moisture. It has fair capacity for holding moisture available to plants.

The productivity is a little lower than that of the type. The soil is suited to crops requiring tillage, but it is limited in this use by its susceptibility to erosion and the heavy consistence of the subsoil. It is not suited to tobacco and root crops, as potatoes, and row crops should not be grown frequently. It is well suited to pasture and hay crops.

Practically all this soil is cleared and used for crops or pasture. More than 60 percent is used for hay and pasture, about 20 percent for corn, and most of the rest for small grains. Little fertilization is practiced and not much lime has been used. Lengths of rotations vary. Some areas are used in short rotations, whereas a few of the more isolated areas are used almost wholly for pasture. Cover crops other than small grains are not commonly grown, and not much organic matter is returned to the soil either by barnyard manure or green-manure crops. Under average conditions, corn yields 22 bushels, wheat 10 bushels, and lespedeza 0.8 ton an acre. Meadow and pasture crops are of good quality, and the pasture has a fairly high carrying capacity. Heavier fertilization, the addition of organic matter, and probably in places, applications of lime will increase yields materially. Because of its susceptibility to erosion and its relatively high productivity for legume and grass hay and pasture crops, a rotation consisting chiefly of fall-sown small grains, hay, and pasture is well suited to this soil.

Guthrie silt loam.—A gray poorly drained soil occupying some of the sinkholes common to areas overlying limestone. It consists of local alluvium washed from soils developed over limestone. The surface is nearly level or saucerlike, there are no surface drains from the areas, and internal drainage is very slow. Areas are waterlogged in winter and spring but the rest of the year they may be very dry and hard for weeks at a time. The native vegetation was water-tolerant deciduous trees including sweetgum, water oak, and willow oak. Few areas occupy more than 3 acres; most of them are associated with Fullerton, Clarksville, and Bolton soils.

A profile description is as follows:

0 to 8 inches, mellow gray silt loam.
8 to 20 inches, gray mottled with yellow and brown firm silty clay loam.
20 inches +, gray plastic clay.

Areas subject to flooding by runoff from cultivated areas commonly have a light-brown to dark-brown overwash layer a few inches thick on the surface, the color of the overwash corresponding to the soil from which it was transported. In places the plastic clay of the lowest layer is somewhat mottled with yellow and brown.

The soil is slightly to strongly acid. It is very low in plant nutrients and organic matter and not high in lime. The surface layer is permeable and friable, but the lower subsoil is very slowly permeable to moisture and roots. Moisture relations are unfavorable for good crop growth.

Because of its poor workability and irregular and generally low productivity, the soil is not well suited to crops. Its unfavorable moisture relations make it poorly suited most of the time for crops commonly grown, although some areas produce good yields during exceptionally favorable seasons. Most areas are best used for permanent pasture and hay.

About 90 percent of the soil is cleared, and most of it is used for hay and pasture. Very little corn is grown and no alfalfa, tobacco, or potatoes. Yields of these crops are generally low. The quality of pasture is not high, and the grazing periods are relatively restricted.

Fertilization, organic matter, and lime will increase yields of crop and pasture plants, and drainage would be of considerable advantage to crops but in general it is impractical, because of the very slow permeability of the subsoil and the lack of drainage outlets.

Hayter loam.—A brown friable soil, consisting of material derived from acid sandstone and shale influenced by or mixed with material from limestone or other calcareous rocks. It is formed on local alluvium. Its material has been washed chiefly from Muskingum soils with material from Armuchee, Decatur, and Sequoia soils intermixed. All areas lie below although not commonly adjacent to outcroppings of limestone and are very likely influenced by lime-bearing water. Internal drainage is very good. The surface is gently sloping, the gradient ranging to about 5 percent. Most areas lie as gentle slopes below the undulating to rolling upland of the limestone valleys and adjacent bottom lands of the creek. Separate areas vary greatly in size, rang-

ing up to about 30 acres and most of them are in Richland Valley. The native vegetation was probably deciduous hardwoods.

A profile description is as follows:

0 to 15 inches, brown mellow loam.
15 to 35 inches, reddish-brown or yellowish-brown friable clay loam.
35 inches +, moderately splotched brown, yellow, red, and gray friable silty clay loam.

A part of this soil has lost some of its surface as a result of erosion. Here the surface layer is 5 to 8 inches thick and in a very few places, some subsoil has been mixed with the surface soil material by tillage. The entire soil is medium acid. It is high in plant nutrients and has a fair quantity of organic matter. Tilth is good, and the soil, permeable to roots and moisture, is capable of holding a relatively large quantity of moisture available to plants.

This is one of the most desirable soils of the county for crops and pasture. It is very productive, is easily worked, and is not difficult to conserve the fertility and soil material from losses by erosion and leaching. It is well suited to practically all crops including tobacco, alfalfa, and truck crops.

Practically all this soil has been cleared and is now in crops and pasture. About 40 percent is used for corn, 15 percent for tobacco, 20 percent for small grains, and 25 percent for hay and pasture. It is used in a short rotation, and row crops are grown at frequent intervals. Tobacco is fertilized heavily but only moderate to light applications are made for other crops; some receiving none. Yields of all crops are high. Corn yields about 40 bushels, barley about 25 bushels, and tobacco about 1,400 pounds an acre. Crops respond well to fertilization and lime and with the favorable tilth and moisture relations consistently large yields can be produced where the supply of plant nutrients, lime, and organic matter are maintained at a high level. Where row crops are grown at frequent intervals, legume cover crops for green manure are of great advantage in maintaining the fertility and organic matter. This soil supports very good pasture vegetation, and because of its favorable moisture relations, good grazing is maintained on it during dry seasons much better than on most of the soils of the uplands. Under a high level of management, corn yields about 50 bushels, barley about 38 bushels, and alfalfa about 4 tons an acre.

Hayter loam, eroded sloping phase.—This soil differs from the type in having a more sloping surface and in having lost 50 to 75 percent of its surface soil as a result of erosion. It consists of material derived from acid sandstone and shale influenced by or mixed with material from limestone or other calcareous rock. Its material has been washed chiefly from Muskingum soils with material from Armuchee, Decatur, and Sequoia soils intermixed. All areas lie below, although not commonly adjacent to outcroppings of limestone and are very likely influenced by lime-bearing water. Internal drainage is good. The surface is sloping (5 to 15 percent). Most areas lie as slopes below the undulating to rolling upland of the limestone valleys and adjacent to creek bottoms. The separate areas range up to about 30 acres and most of them are in Richland Valley. The native vegetation was deciduous hardwoods.

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A profile description is as follows:

0 to 6 inches, brown mellow silt loam.
6 to 26 inches, reddish-brown or yellowish-brown friable clay loam.
26 inches +, moderately splotched brown, yellow, red, and gray friable silty clay loam.

The thickness of the surface layer varies widely, due to the differences from place to place in the quantity of material removed by erosion. Limited parts have a surface layer more than 8 inches thick, whereas occasional small patches have the subsoil exposed. The soil is medium acid and has fairly good tilth. It is permeable to roots and moisture and is capable of holding a relatively large quantity of moisture available to plants.

The soil is well suited to both crops and pasture. It is very productive and, except for the effect of the moderate slope, is easily worked. Though not very erosive, its moderate slope requires that some precautions be taken to conserve it from losses by runoff.

All this soil has been cleared and cropped. About 40 percent is used for corn and tobacco, 35 percent for hay and pasture, and 25 percent for small grains and other crops. Comparatively short rotations are used, row crops occupying the ground nearly half the time. Tobacco is fertilized but only moderate to light applications are made for other crops, some receiving none. Yields of all crops are high. Under average management, corn yields about 36 bushels, barley 25, and tobacco about 1,400 pounds an acre. Crops respond well to fertilization and lime and with favorable tilth and moisture relations, consistent large yields can be produced where the supply of plant nutrients, lime, and organic matter are maintained at a high level. Where row crops are grown at frequent intervals, legume cover crops for green manure are of great advantage in maintaining fertility and organic matter. Due to the moderately strong slope more care is required to counteract erosion. Row crops should be grown less frequently than on the type, tillage should be on the contour, and terracing is practical on some areas.

Under average management this soil supports a pasture cover of good quality, and with adequate fertilization and liming, it is capable of supporting heavy grazing. Because of its favorable moisture relations, good grazing is maintained more easily on it during dry periods than on many of the soils of the uplands.

Hayter stony loam, eroded phase.—A brown stony friable soil, consisting of a mixture of materials washed chiefly from Muskingum and Armuchee soils, developed on local alluvium and colluvium. Its internal drainage is good. The surface is gently sloping to sloping (2 to 12 percent). Practically all of it is in the area that lies along the northwest border of Clinch Mountain. All the areas are small, few exceeding 10 acres. They are closely associated with Armuchee soils and lie along drains that head in adjacent areas of Muskingum soils on Clinch Mountain. The native vegetation included oak, walnut, locust, maple, and other deciduous hardwoods.

A profile description is as follows:

0 to 8 inches, brown mellow loam containing sandstone fragments 3 to 30 inches in diameter. These fragments are sufficiently abundant to interfere with tillage.

8 inches +, yellowish-brown to reddish-brown friable clay loam containing sandstone fragments. The thickness of the colluvial material over bedrock is 30 inches or more.

The greater part of this soil has lost 50 to 75 percent of its surface soil by erosion, and there are a few small patches where the plow layer contains considerable subsoil material. The entire soil is medium acid, is high in plant nutrients, and has a fair quantity of organic matter. Tilth is good, but stones are sufficiently abundant to interfere materially with field operations. The soil is permeable to roots and moisture, and it holds a relatively large quantity of moisture available to plants.

This very fertile soil is suitable for crops requiring tillage and pasture. Stoniness, however, interferes materially with field operations especially mowing and reaping. It is not difficult to conserve, although the more sloping parts require precautions against erosion.

A large part of the soil is cleared and used for crops and pasture. About 50 percent is used for hay and pasture, 30 percent for corn and tobacco, and 20 percent for small grains and other crops. Yields of all crops are good. Under average management corn produces about 35 bushels, wheat about 18 bushels, and red clover about 1.5 tons an acre. Where adequate fertilization, especially with phosphorus and lime, is practiced and the organic-matter content is maintained at a high level yields are notably higher.

Where fertility is maintained and lime applied, the more exacting small-grain, hay, and pasture crops (barley, red clover, timothy, alfalfa, bluegrass, and white clover) are suited to this soil as well as to the stone-free Hayter soils. Because of its favorable moisture relation, pasture vegetation is maintained better in dry periods than on the soils of the upland. Some precautions are required to counteract erosion inasmuch as the slope is great enough to cause runoff to be active.

Hayter stony loam, hill phase.—A brown stony friable soil, consisting of colluvium washed from Muskingum and Armuchee soils. It is developed on strong slopes (12 to 30 percent). Its internal drainage is good, and its surface is strongly sloping. Practically all of it is along the northwest border of Clinch Mountain. The areas are not large, few of them exceeding 30 acres. They are closely associated with Armuchee soils and lie along drains that head in adjacent areas of Muskingum soils of Clinch Mountain. Most areas of the hill phases are farther up the drains than are the smoother phases. Native vegetation included oak, tuliptree, walnut, locust, maple, and other deciduous hardwoods.

A profile description is as follows:

0 to 10 inches, grayish-brown to brown mellow loam containing a variable quantity of sandstone fragments and boulders ranging from an inch or more to several feet in diameter.

10 inches +, yellowish-brown to reddish-brown friable clay loam containing sandstone fragments and boulders ranging from a few inches to several feet in diameter. The thickness of the colluvial material over bedrock is in general more than 30 inches but rarely exceeds 12 or 14 feet.

In most areas stones and boulders are sufficiently abundant to interfere materially with field operations. In some places they are so plen-

tiful as to make such work impractical; in a few others they are almost completely lacking. The soil is medium acid, fertile, and permeable to roots and moisture. It is capable of holding a relatively large quantity of moisture available to plants.

Because of their stoniness and strong slope all but the least stony areas are physically poorly suited to crops requiring tillage. The fertility of the soil and its favorable moisture relations make it well suited to pasture. Bluegrass and white clover are well suited to pasture areas.

About 50 percent of this soil is cleared and most of it is used for pasture. The more stony areas especially are not easily worked and the characteristic long slopes of relatively strong gradients are notably subject to runoff hazards. The less stony areas may be suitable for limited cropping not involving the use of heavy machinery and where precautions are taken to prevent erosion. Where fertility is maintained and lime requirement fulfilled, very good pasture is easily maintained, although care must be taken to prevent erosion and to remove the brushy growth.

Hayter stony loam, eroded hill phase.—Differing from the type this brown stony friable soil has lost 50 to 75 percent of its original surface layer as a result of erosion. It is developed on strong slopes, consisting of colluvium washed from Muskingum and Armuchee soils. The surface is strongly sloping (12 to 30 percent). Internal drainage is good. Practically all of it is along the northwest border of Clinch Mountain. The areas are of moderate size, some of them ranging to about 40 acres. They are closely associated with Armuchee soils and lie along drains that head in adjacent areas of Muskingum soils on Clinch Mountain. The native vegetation included oak, tuliptree, walnut, locust, and maple, with other deciduous hardwoods.

A profile description is as follows:

0 to 5 inches, brown or grayish-brown mellow loam, containing a variable quantity of sandstone fragments and boulders ranging from an inch to several feet in diameter.

5 inches +, yellow-brown to reddish-brown friable clay loam, containing sandstone fragments and boulders. The thickness of the colluvial material over bedrock is in general more than 30 inches but rarely exceeds 12 or 14 feet.

The thickness of the surface layer varies according to the erosion that has taken place. In a few places, where erosion has been least active, it may be 8 to 10 inches thick but where it has been most active, the subsoil is exposed and the plow layer consists almost wholly of subsoil material. In most areas stones and boulders are sufficiently abundant to interfere with field operations; in some places they are so plentiful as to make such activities impractical; and in a few others, they are almost completely lacking. The soil is medium acid, fertile, permeable to roots and moisture, and holds a relatively large quantity of moisture available to plants.

Because of their stoniness and strong slope, all but the least stony areas are considered poorly suited to crops requiring tillage. The fertility of the soil and its favorable moisture relations make it well suited to pasture. Bluegrass and white clover are common pasture plants in permanent pasture.

All this soil has been cleared and most of it is now used either for crops or for pasture. About 75 percent is being used for hay or pasture, and the rest for corn, small grains, and tobacco. Little fertilization is practiced except for tobacco, which receives comparatively heavy applications. Under average management on the less stony areas, corn yields about 25 bushels, wheat about 14, and tobacco about 1,000 pounds an acre. A large part of this soil probably can be used best as pasture. The less stony areas that are required for crops should be used in a long rotation, consisting chiefly of fall-sown small grains and hay crops. Red clover and alfalfa produce well where the fertility has been maintained at a high level and lime is applied at the rate of about 2½ tons an acre. Cultivation should be kept at a minimum, and all field operations should be on the contour. In general pastures respond to lime and phosphorus and where so treated and kept clear of brush and weedy growth, they produce good quality grazing and have a high carrying capacity. Some care is required to avoid overgrazing on the more severely eroded places.

Hayter stony loam, steep phase.—This brown friable stony soil, developed on steep slopes (30 to 50 percent), consists of colluvium washed from Muskingum and Armuchee soils. External drainage is excessive or very rapid. Internal drainage is good. Practically all of this phase is along the northwest edge of Clinch Mountain. The areas range to about 60 acres in size, and a large part of the acreage lies as steep slopes below steep and very steep Armuchee soils and within less than a fourth of a mile of the Muskingum soils on Clinch Mountain. The native vegetation consisted of oak and tuliptree, with walnut, locust, chestnut, maple, and pine intermixed.

A profile description is as follows:

0 to 8 inches, grayish-brown to brown mellow loam, containing a variable quantity of sandstone fragments and boulders ranging from an inch or more to several feet in diameter.

8 inches +, yellowish-brown to reddish-brown friable clay loam, containing sandstone fragments and boulders ranging from a few inches to several feet in diameter. The thickness of the colluvial material over bedrock is in general more than 24 inches but probably rarely exceeds 12 feet.

The thickness of the surface layer and the depth to bedrock are more variable than for the less steep types. In most areas the stones and boulders are sufficiently abundant to interfere materially with cultivation, and in most places they are so numerous as to make such work impractical. The soil is medium acid, fertile, and permeable to roots and moisture. It is capable of holding a relatively large supply of moisture available to plants.

Because of its steep slope and stoniness, this soil is not suited to crops requiring tillage. It is capable of affording good pasture, as bluegrass and white clover grow well on it.

Practically all this soil is occupied by cut-over forest consisting of oak, tuliptree, and other deciduous hardwood species with a variable quantity of undergrowth. Cleared areas afford good grazing, but brush growth may require frequent clearing at least until pasture has been well established for several years.

Hayter stony loam, eroded steep phase.—This brown friable stony soil, developed on steep slopes (30 to 50 percent), consists of colluvium washed from Muskingum and Armuchee soils. External drainage is excessive or very rapid, and internal drainage is good. Practically all the soil is along the northwest edge of Clinch Mountain. The areas range to about 60 acres in size, and a large part of the acreage lies as steep slopes below steep and very steep Armuchee soils and within less than a quarter mile of the Muskingum soils on Clinch Mountain. The native vegetation was chiefly oak and tuliptree, with walnut, locust, chestnut, maple, and some pine intermixed.

A profile description is as follows:

0 to 5 inches, brown or grayish-brown mellow loam, containing a variable quantity of sandstone fragments and boulders ranging from an inch to several feet in diameter.

5 inches +, yellowish-brown to reddish-brown friable clay loam, containing sandstone fragments and boulders.

The thickness of the colluvial material over bedrock is in general more than 2 feet but rarely exceeds 12 feet. Because of variations in the quantity and rate of both geologic and accelerated erosion, the thickness, color, and texture of the surface layer vary widely. In most areas stones and boulders are sufficiently abundant to interfere materially with cultivation, and in some places they are so plentiful as to make cultivation, except by hand, impractical. The soil is medium acid, fertile, and permeable to roots and moisture. It is capable of holding a relatively large supply of moisture available to plants.

Because of its steep slope and stoniness, this soil is not suited to crops requiring tillage. Its best use is for pasture, and bluegrass and white clover do well on it.

All this soil has been cleared and used in such a way as to cause it to become eroded. A large part of it is used for permanent pasture, about 15 percent has been abandoned to forest or brushy growth, and possibly 10 percent is used for crops, principally corn. Permanent pasture or forest is its best use. Most of it is capable of supporting good quality grazing, especially if lime and phosphorus are applied. Some care is required to prevent erosion, and brushy growth commonly requires periodic cutting.

Hayter stony loam, severely eroded steep phase.—As a result of erosion this yellowish-brown stony loam soil differs from the steep phase in having lost practically all of its original surface soil. This phase is developed on steep slopes of colluvium washed from Muskingum and Armuchee soils. The gradient ranges from 30 to 50 percent, consequently external drainage is excessive or very rapid. Internal drainage is fair to good. The more permeable surface soil has been lost. In most areas gully erosion has been sufficiently active to cause the surface to be uneven, and those areas that have not been tilled for several years have some gullies, many of which are difficult or impossible to cross with machinery. The larger gullies are shown on the soil map by appropriate symbols.

Practically all this phase occurs along the northwest edge of Clinch Mountain. The areas range up to about 30 acres, and a large part of the acreage lies at steep slopes below steep to very steep Armuchee

soils and within less than a fourth of a mile of the Muskingum soils on Clinch Mountain. Native vegetation was chiefly oak and tuliptree, with walnut, locust, maple, and some pine intermixed.

The entire profile consists of yellowish-brown to reddish-brown friable clay loam, containing sandstone fragments and boulders. The thickness of the colluvial material over bedrock is in general more than 24 inches but probably rarely exceeds 10 or 12 feet. The stones and boulders in most areas are sufficiently abundant to interfere materially with cultivation and in some places, they are so plentiful as to make cultivation, except by hand, impractical. The soil is medium acid, fertile, and permeable to roots and moisture. It is capable of holding a moderate supply of moisture available to plants.

Because of its steep slope, stoniness, and severely eroded condition, this soil is poorly suited to crops and pasture. Unless special effort is taken to improve its productivity, it probably is best suited to forest.

At some time all the soil has been cleared and cropped, but nearly 90 percent of it is now abandoned to unimproved pasture or forest. The rest is used for corn and improved pasture. Yields are low under average management, which includes little fertilization and involves tillage, which should not be practiced on areas of this nature. This soil should be either forested or fertilized sufficiently to enable good sod to develop. The latter will probably require fertilization, liming, and the addition of organic matter either by manure or by growing strong-rooted crops, as sweetclover and sericea lespedeza. When sufficiently rejuvenated, it should be capable of supporting bluegrass and white clover. Locust, walnut, tuliptree, and other deciduous hardwoods are suited to this soil.

Hector stony fine sandy loam.—A steep light-red soil of the upland associated with the Muskingum soils, developed from sandstone and shale of the Clinch and Clinton geologic formations. Internal drainage is good. The surface is steep (30 to 60 percent). A large part of this lies as a steep lower slope on the southeast side of Clinch Mountain west and northwest of Tate Springs. The native vegetation was shortleaf (yellow) pine and deciduous hardwoods, chiefly oak and hickory, with some chestnut and other deciduous species.

A profile description is as follows:

0 to 10 inches, grayish-yellow moderately loose fine sandy loam.
10 to 30 inches, yellowish-red grading with depth to red friable fine sandy clay. The lower few inches are generally red splotched with yellow, brown, and gray friable fine sandy clay resting on bedrock sandstone.

Sandy fragments are throughout the soil mass and not uncommonly are sufficiently abundant to prohibit tillage. The soil is medium to strongly acid, moderately fertile, and permeable to roots and moisture. Its capacity for holding water available to plants is fairly good. The depth to bedrock varies from less than 2 feet to possibly 4 or 5 feet, and the thickness of the surface layer varies greatly because of erosion. About 45 percent of the type is unaffected by erosion resulting from clearing and cultivation, about 20 percent has lost an appreciable part of the surface soil, and about 35 percent has lost practically all the surface soil and in places, part of the subsoil.

Because of its steep slope and stoniness, this soil is not well suited to

either crops or pasture, although some of the cleared areas may be suitable for pasture if properly fertilized and managed.

About 65 percent of this soil has been cleared, but about three-fourths of this has been abandoned to unimproved pasture or reestablished pine forest. Areas suitable for pasture should be treated particularly with phosphorus and lime and seeded to pasture plants, as lespedeza, redtop, and orchard grass.

Hilly stony land (Talbott soil material).—Characterized by limestone outcrops sufficiently abundant to prohibit feasible tillage, areas of this land type are commonly referred to as rockland or limestone rockland. In most areas these outcrops occupy 10 to 50 percent of the surface. The soil material resembles that of either Talbott or Armuchee soils. The surface few inches are grayish-brown silty clay loam underlain by yellowish-red or reddish-yellow plastic silty clay. Depth to bedrock limestone varies but seldom exceeds 3 feet. Some of the areas represent Talbott and Armuchee soils that have been eroded sufficiently to expose the underlying bedrock.

The surface of this land type is hilly, the gradient ranging mostly from 12 to 30 percent. Sinkholes are common. Most of the soil material is fertile, but as internal drainage is very slow, much of it is droughty.

A large part of this land type is in Richland and Clinch Valleys. The native vegetation was predominantly cedar, oak, hickory, locust, and tuliptree.

The numerous rock outcrops make this land type poorly suited to crops. Practically all areas, however, are sufficiently productive of grasses to be suited to pasture. About 70 percent of it has been cleared and practically all of it is used as permanent pasture. The grazing capacity varies according to thickness of the soil material over rock, abundance of rock outcrops, exposure, and care that has been taken to maintain the soil material and its fertility. Bluegrass and white clover are suited to it and they respond well to proper fertilization and liming. Weeds and brushy growth are difficult to suppress because of the general impossibility of using a mower to cut them.

Hilly stony land (Colbert soil material).—Areas of this land type are commonly referred to as gladyland, limestone rockland, or rockland. They consist of a great number of small shalelike or soft flaggy limestone fragments intermixed with a thin layer of Colbert soil material and a great many shallow rather flat outcrops of limestone bedrock. The fragments and outcrops occupy more than 50 percent of the surface. The limestone is clayey or argillaceous and most of it is of Ottosee shale or Moccasin limestone formation. Rock outcrops rarely protrude more than 6 inches. The soil material is predominantly plastic clay, a characteristic of the Colbert subsoil. That overlying Moccasin limestone is purplish red; the other areas are predominantly yellow. Very little of this material is more than 12 inches thick over bedrock and much of it is less than 6 inches. The surface is rolling to hilly, the gradient ranging from 5 to 30 percent. Internal drainage is very slow, and the moisture-holding capacity is low. The content of plant nutrients is moderate, and the reaction is medium to strongly acid. The native vegetation was predominantly redcedar.

The greater part of this land type is in Clinch Valley. This land type is too stony or rocky and too shallow to bedrock to be suited to crops. It affords some pasture but its suitability for this use is limited by unfavorable moisture relations and the abundance of rock outcrops.

A small part is cleared and used for pasture, but a great part is forested with cut-over redcedar. Its grazing capacity is low, and the rate of growth of the forest cover is slow. The part in which the thickness of the soil material is 6 inches or more is probably worth improving for pasture, and on these parts bluegrass and white clover respond to applications of phosphorus and lime.

Holston very fine sandy loam.—This soil occupies old stream terraces, consisting of a mixture of materials from limestone, sandstone, and shale. The gray surface layer is smooth, the gradient not exceeding 5 percent, and the subsoil is yellow and permeable. Internal drainage is good. The separate areas are widely distributed on the irregular areas of stream terraces along the Holston River. A large part of the acreage is now inundated by the Cherokee Reservoir, the only significant areas not under water being on Mitchell Bend about 5 miles southeast of Blaine. Native vegetation was oak, hickory, and other deciduous hardwoods, with some shortleaf pine intermixed.

A profile description is as follows:

0 to 10 inches, gray friable very fine sandy loam.
10 to 30 inches, yellow firm but moderately friable sandy clay.
30 inches +, splotched yellow, red, gray, and brown friable sandy clay. Irregular beds of cobbles may be at a depth of 3 or 4 feet, and bedrock is generally at a depth of 3 to 10 feet.

This soil is medium to strongly acid and is low in plant nutrients and organic matter. It is permeable to roots, and its capacity for holding moisture available to plants is moderately good.

Some areas have lost a part of the surface soil by erosion, and in these places some subsoil material is included in the plow layer. In most areas a few cobbles, chiefly quartzite, are throughout the soil, and in a few places they are sufficiently abundant to interfere with field operations. The most gravelly areas are indicated on the soil map by appropriate symbols.

This soil is suited to crops requiring tillage and to pasture. Its smooth surface and friable nature make it easy to work except where cobblestones are abundant. It is not difficult to conserve against soil losses by erosion under proper management, although the more sloping parts require some special care. Its productivity, however, is moderately low and is not so easily maintained at a high level as is that of the smooth soils of the Hayter and Decatur series.

Practically all this soil has been cleared and cropped. Prior to the establishment of the Cherokee Reservoir about 45 percent was used for hay and pasture, about 30 percent for corn, and the rest for small grains and other crops. Lespedeza and redtop were the most common hay crops. Moderately short rotations were common, and only light applications of fertilizer were made, principally to the wheat and corn crops. Little barnyard manure had been applied and green-manure crops were not common. Where tobacco was grown, however, moderate applications of barnyard manure with mixed fertilizer were almost invariably

used. Some lime has been applied in places. Under average management, corn yielded about 23 bushels, wheat about 10 bushels, and lespedeza about 0.8 ton an acre.

Increased fertilization, lime and organic matter, and increased use of legumes in the rotation are among the chief requirements of good management. The soil is capable of supporting a moderately short rotation where the fertility is maintained at a fairly high level. Cover crops should be used where the ground would otherwise be bare through the winter season in order to prevent erosion and retain plant nutrients from leaching. Where the fertility is maintained at a high level, legumes and grasses, as red and white clovers, alfalfa, and bluegrass, are suited but at lower levels of fertility, lespedeza, redtop, and orchard grass are preferred. Under average conditions pasture is fair and consists chiefly of lespedeza, broomsedge, and redtop. The quality and quantity of grazing furnished are greatly improved by proper fertilization, especially with phosphorus and lime. Suppression of weeds and brushy growth by mowing is generally necessary to maintain a clean pasture cover of good quality. Under a high level of management, corn yields about 33 bushels, barley about 22 bushels, and lespedeza about 1.3 tons an acre.

Holston very fine sandy loam, eroded sloping phase.—This phase differs from the type in having a more sloping surface and in having lost 50 to 75 percent of its original surface layer by erosion. In places sufficient material of the original surface layer has been lost to cause subsoil material to have been mixed with the surface layer material by cultivation. It is a yellow moderately friable soil developed on old stream terraces, consisting of a mixture of material derived from limestone, sandstone, and shale. The surface is sloping (5 to 12 percent). Internal drainage is good, although somewhat impaired by the moderately heavy nature of the subsoil. The separate areas are widely distributed on the stream terraces along the Holston River. A large part of the acreage is now inundated by the Cherokee Reservoir, the only significant areas not under water being on Mitchell Bend about 5 miles southeast of Blaine. The native vegetation was oak and hickory, with some other deciduous hardwoods and shortleaf pine intermixed.

A profile description is as follows:

0 to 5 inches, yellowish-gray very fine sandy loam. The plow layer of the most eroded patches is yellow sandy clay loam.

5 to 25 inches, yellow firm but friable sandy clay.

25 inches +, splotched yellow, red, gray, and brown friable sandy clay. Irregular beds of cobbles may be at a depth of 3 or 4 feet, and bedrock is generally at a depth of 3 to 8 feet.

This soil is medium to strongly acid and is low in plant nutrients and organic matter. Because of the shallower depth to the subsoil, infiltration of water is slower and the ability of the soil to hold moisture for plants is less than that of the smoother less eroded type. In most areas a few cobbles, chiefly quartzite, are throughout the soil and in a few others, they are sufficiently abundant to interfere with field operations. The most gravelly areas are represented on the soil map by appropriate symbols.

This soil is suited to crops and pasture, but because of its slope and

low fertility, the management requirements for maintaining it in a moderately productive state are exacting. Long rotations, consisting chiefly of legume hay and pasture crops, are among the better uses for it.

About 90 percent of this soil has been cleared and used for crops. Prior to the establishment of the Cherokee Reservoir, about 50 percent of it was used for hay and pasture, 25 percent for corn, and most of the rest for small grains. Fertilization has been light and chiefly for wheat and corn, and only a small quantity of lime has been applied. Greenmanure and cover crops other than the fall-sown small grains have not been common. Under average conditions, corn yields about 20 bushels, wheat about 9 bushels, and lespedeza about 0.5 ton an acre.

This soil requires heavy fertilization, lime, organic matter, and a moderately long rotation in order to be maintained in a relatively productive state. Plowing should be infrequent, and row crops should not be grown more than once in 4 or 5 years. Good management requires that the soil be protected by a cover crop in winter where it would otherwise lie bare. Rotations of fall-sown small grains and hay and pasture crops are well suited to this soil. When the fertility is maintained at a high level and lime has been applied, red clover, white clover, timothy, and bluegrass are suited; when the fertility is not maintained at a high level, lespedeza, redtop, and orchard grass are preferable for hay pasture. Under average conditions pasture, consisting chiefly of lespedeza, broomsedge, and redtop, is only fair. The quality and quantity of grazing are greatly improved by proper fertilization, especially by using phosphorus and lime. Mowing is almost invariably necessary in order to prevent weedy and brushy growth from encroaching on the pasture. Under a high level of management, corn yields about 30 bushels, wheat about 13, and lespedeza hay about 1.1 tons an acre.

Huntington silt loam.—This brown fertile well-drained soil consists of alluvium derived chiefly from limestone with material from sandstone and shale intermixed. The surface is level to gently undulating and all areas, prior to the establishment of the Cherokee Reservoir, were subject to overflow. Inundation is now less frequent and less extended because of partial control of stream flow by the Cherokee Reservoir. Internal drainage is good to a depth of 2½ or 3 feet. The aggregate area is small, and some of it was covered by the Cherokee Reservoir. All the areas are on the first bottoms of the Holston River and the largest ones are south and southeast of Richland. Practically all areas are associated with the Bruno soils of the first bottoms. The native vegetation consisted of certain species of oak and maple and some beech, walnut, elm, hickory, and other deciduous hardwoods.

A profile description is as follows:

0 to 15 inches, brown mellow silt loam.
15 to 36 inches, lighter brown and generally of finer texture and firmer consistence than the surface layer.
36 inches +, yellowish-brown moderately mottled with gray silt loam. The depth to bedrock is generally more than 10 feet.

This soil is slightly acid to neutral. Its natural fertility is high and the content of organic matter is moderately high. It is easily permeable to both moisture and roots, and its capacity for holding moisture available to plants is large.

This soil is well suited to intensive use under good management. It is one of the most productive soils of the county, is smooth, and has good tilth, although moisture conditions interfere more with field operations than on some of the sandier and higher lying soils. Inasmuch as erosion is not active and plant nutrients are retained well, the soil is easily conserved. Most crops, except tobacco and in some places possibly alfalfa, are well suited to it.

Practically all this soil has been cleared and used for crops and pasture. Corn occupies a large part of the acreage, many fields being used several years in succession for it. Some hay and small grain are raised. Very little fertilizer is used, and lime is not required for legumes on most areas. Crop yields are relatively high. Under average management, corn yields about 40 bushels and lespedeza about 1.7 tons an acre. Somewhat higher yields can be expected with the use of greater quantities of fertilizer and some rotation of crops. Unless fertilization is properly balanced, most small grains lodge. Hay and pasture crops are of good quality and yield well. Areas not subject to flooding are probably well suited to all legumes, including alfalfa. Bluegrass and white clover are common where they are allowed to establish and afford good grazing for a large part of the grazing season due to the favorable moisture relations of the soil.

Included in this soil type are a few areas that have a silty clay loam texture and somewhat heavier consistence.

Jefferson stony fine sandy loam, eroded phase.—A somewhat yellow fine sandy loam soil on gentle local alluvial-colluvial slopes below and adjacent to areas of hilly to steep Muskingum soils and consisting of material washed from these soils. The surface is gently sloping, the gradient not exceeding 5 percent. Some of the areas lie along drainageways issuing from areas of Muskingum soils. Internal drainage is good. More than half of this soil has lost 50 to 75 percent of its surface layer by erosion. The aggregate area is small, most of it being in Poor Valley. A few small areas are in Richland Valley along the base of Poor Valley Ridge. The separate areas are small and are associated with extensive areas of soils not suited to crops requiring tillage. The native vegetation was oak, hickory, and other deciduous hardwoods, with some shortleaf pine intermixed.

A profile description is as follows:

0 to 6 inches, brownish-gray or yellowish-gray mellow fine sandy loam, containing numerous sandstone fragments 2 to 6 inches in diameter.

6 to 28 inches, yellowish-brown firm but friable sandy clay, containing numerous sandstone fragments.

28 inches +, splotched brownish-yellow, gray, and reddish-brown friable sandy clay, containing numerous sandstone fragments. Bedrock sandstone lies at a depth of 4 to more than 20 feet.

This soil is strongly acid and is low in plant nutrients and organic matter. It is permeable to roots and moisture and its capacity for holding moisture available to plants is fairly good.

The thickness of the surface layer varies greatly. Those areas that have not been eroded materially (about 1/3 of the acreage) have a surface layer about 10 inches thick; on the other hand, a small part has

been sufficiently eroded to cause subsoil material to be mixed to a large extent with the thin remaining part of the original surface layer. The degree of stoniness also varies notably. Most areas are sufficiently stony to be difficult to till; there are a very few that are so stony as not to be suited to tillage. There are also a few areas along the southeast edge of Poor Valley Ridge that are free of stone.

This soil is suited to practically all the crops commonly grown and to pasture. Its productivity is low but it responds well to good management. Its stoniness interferes with cultivation but its tilth is good except in the very few small most eroded patches. It is not difficult to conserve against losses by runoff, but it is not so easy to maintain in a highly productive state as are such soils as the Hayter and Emory.

All except a very small part of this soil is cleared and used either for crops or for pasture. About 45 percent is used for corn, 30 percent for hay and pasture, and 25 percent for small grains and other crops, including a small acreage of tobacco. Heavy applications of manure and fertilizer are used for tobacco, but little is used for the other crops. A few areas have probably been limed. Corn, small grain, and hay are rotated irregularly and legume cover crops are not in common use. Lespedeza and redtop are the chief hay crops and pasture vegetation consists chiefly of broomsedge and lespedeza, with some orchard grass intermixed. Areas in pasture for several years generally have a large quantity of brushy and weedy growth in them. Under average management corn yields about 14 bushels, wheat 6 bushels, and lespedeza about 0.5 ton an acre. Moderately short rotations are suited to this soil providing fertilization is heavy. This soil is in need of all the plant nutrients, organic matter, and lime. Regular fertilization should be practiced, and legume cover crops turned under as green manure can do much toward aiding in maintaining this soil in a productive state. A 3- or 4-year rotation, consisting of a row crop, fall-sown small grain, and a hay or pasture crop, is suitable providing ample fertilization and liming are practiced. Where the fertility is brought to a high level, red clover, timothy, white clover, and bluegrass are probably suitable for hay and pasture but where the fertility is not brought up considerably, lespedeza, redtop, and orchard grass are better suited. Under good management corn may yield about 25 bushels or more, wheat 10 bushels, and lespedeza 0.8 to 1.0 ton an acre.

Jefferson stony fine sandy loam, sloping phase.—This soil represents uneroded areas of the type on slopes of 5 to 15 percent. It is developed on local alluvial-colluvial slopes below and adjacent to areas of hilly and steep Muskingum soils. These colluvial areas consist of material washed from the Muskingum soils, which are developed over sandstone. Internal drainage is good. All the areas are small and most of them are in Poor Valley. They are generally associated with extensive areas of steep, stony soils not suited to crops requiring tillage. The native vegetation is predominantly oak, hickory, and other deciduous hardwoods, with some shortleaf pine intermixed.

A profile description is as follows:

0 to 9 inches, brownish-gray mellow fine sandy loam, containing numerous sandstone fragments 2 to 6 inches in diameter.

9 to 30 inches, yellowish-brown firm but friable sandy clay, containing numerous sandstone fragments.

30 inches +, splotched, brownish-yellow, gray, and reddish-brown friable sandy clay, containing numerous sandstone fragments. Bedrock sandstone lies at a depth of 3 or 4 to more than 20 feet.

This soil is strongly acid and is low in plant nutrients and organic matter. It is permeable to roots and moisture, and its capacity for holding moisture available to plants is fairly good.

This soil is suited to crops and pasture but its low fertility, stoniness, and slope limits its usefulness. Its productivity is low, its workability is only fair, and runoff control requires some special effort. Most of the crops common to the area are suited to this type, although the more exacting ones, as tobacco, red clover, and alfalfa, require a high state of fertility.

Practically all this soil is under forest, therefore very little has been cropped. Good management involves a moderately long rotation and substantial fertilization and liming. Cover crops should be used when the surface otherwise would be left bare in winter. Organic matter is required if a moderately high productivity is to be maintained. Field operations should be on the contour and terraces may be feasible in places. Good pasture vegetation requires at least substantial applications of phosphorus and lime. Under good management, corn yields about 20 bushels, wheat 8 to 10 bushels, and lespedeza 0.7 to 1 ton an acre.

Jefferson stony fine sandy loam, eroded sloping phase.—As a result of erosion this soil differs from the sloping phase of the type in having lost 50 to 75 percent of the surface soil. It is on sloping areas (5 to 15 percent) of local alluvial-colluvial material below and adjacent to areas of hilly and steep Muskingum soils. These colluvial areas consist of material washed from the Muskingum soils, which are developed over sandstone. Internal drainage is good. This is the most extensive of the Jefferson soils. Most of it is in Poor Valley. A few areas are along the southeast edge of Poor Valley Ridge in Richland Valley. All the areas are associated with extensive areas of steep, stony soils not suited to crops requiring tillage.

A profile description is as follows:

0 to 5 inches, brownish-gray or yellowish-gray mellow fine sandy loam, containing numerous sandstone fragments, 2 to 6 inches in diameter.

5 to 26 inches, yellowish-brown firm but friable sandy clay, containing numerous sandstone fragments.

26 inches +, splotched brownish-yellow, gray, and reddish-brown friable sandy clay, containing numerous sandstone fragments. Bedrock sandstone lies at a depth of 3 or 4 feet to more than 20.

This soil is strongly acid and is low in plant nutrients and organic matter. It is permeable to roots and moisture and its capacity for holding moisture available to plants is fairly good.

A small part of this soil is stone-free, and most of the areas are in Richland Valley. There are also a few patches that are so stony as to make tillage impractical. Small patches especially on the more exposed

knobs have lost practically all their surface soil and here the plow layer consists largely of subsoil material.

This soil is suited to crops and pasture but its low fertility, stoniness, and slope limit its usefulness. Its productivity is low, its workability is only fair, and runoff control requires some special effort. Most of the crops common to the area are suited to it, although the more exacting ones, as tobacco, red clover, and alfalfa, require a high state of fertility.

All this soil has been cleared and most of it is being used either for crops or for pasture. About 30 percent is used for corn and other row crops, about 20 percent for small grains, and about 50 percent for hay and pasture. Small applications of fertilizer are used for wheat and for some corn and a little lime has been applied to some areas. Most of the limited supply of manure is used for row crops. Systematic rotation is not practiced. Some fields that become unproductive as a result of continuous cropping are allowed to lie idle as unimproved pasture for a period of years, after which they are cropped again. Under average management corn yields about 10 bushels, wheat 5 bushels, and lespedeza hay about 0.4 ton an acre.

This soil should be used in a moderately long rotation including legume hay and pasture crops, fall-sown small grains, and where the ground would otherwise be bare, legume cover crops. Substantial applications of fertilizer and lime are essential and organic matter should be added either through green-manure crops or barnyard manure. Where the fertility is maintained at a high level and lime has been applied in an adequate quantity, hay and pasture crops as red clover, white clover, alfalfa, timothy, and bluegrass may be preferred, but unless a high state of fertility is maintained, lespedeza, redtop, and orchard grass are better suited. Generally clean pastures of high quality require mowing at intervals sufficient to suppress brush and weed growth. Where row crops must be frequently grown, particular care is required to control runoff. All tillage should be on the contour, and terracing and strip cropping may be practical in places. The more stony areas are probably best suited to permanent pasture. Under good management, corn yields about 20 bushels, wheat 8 to 10 bushels, and lespedeza hay 0.7 to 1 ton an acre.

Leadvale silt loam.—This somewhat yellow silt loam occurs on local alluvial-colluvial areas below and adjacent to those of Lehew, Muskingum very fine sandy loam, Montevallo, and Armuchee soils. These areas consist of material washed from these soils, the parent rock of which is predominantly acid shale. The surface is gently sloping, the gradient seldom exceeding 5 percent. Although most areas are on gentle slopes at the foot of hilly and steep slopes, a few occur as narrow strips along drains extending into hilly and steep areas. Internal drainage is fair. This type is a little less favorable for most crops than the Jefferson soils. Some areas are adjacent to Lehew soils and are in Potato Valley along the southeast side of Log Mountain. The largest areas are along the southeast edge of Poor Valley Ridge. All the areas are small and are in landscapes consisting predominantly of soils poorly suited to crops. The native vegetation was chiefly oak and other deciduous hardwoods, with some shortleaf pine intermixed.

A profile description is as follows:

0 to 8 inches, brownish-gray mellow silt loam.
8 to 27 inches, yellow or yellowish-brown firm silty clay loam.
27 inches +, moderately mottled yellow, gray, and brown silty clay loam, a little more friable than the layer above. Bedrock is at a depth of more than 36 inches and may be more than 10 feet in places.

This soil is medium to strongly acid and is low in plant nutrients and organic matter. It is moderately permeable to roots and moisture, although somewhat less so than the Fullerton and Clarksville. Infiltration is sufficiently retarded to cause runoff to develop rather easily. Its capacity for holding moisture available to plants is fairly good. Most areas associated with the Lehew soils are purplish yellow or reddish gray and have many small sandy shale fragments in them.

This type is suited to crops and pasture and under good management and adequate fertilization is capable of supporting a moderately short rotation. Its productivity is fair, it is easily worked, and it is not difficult to conserve. Moisture relations are relatively good for most crops, although alfalfa may not be suited to the more slowly drained parts.

Nearly all this soil is cleared and used for either crops or pasture. About 30 percent is used for corn, about 25 percent for small grains, and about 45 percent for hay and pasture. Light applications of fertilizer are used for wheat and for some of the corn, and lime may have been applied to a small acreage. Barnyard manure and cover crops for green manure are not commonly used. Lespedeza and redtop are the chief hay crops. Pasture vegetation consists of broomsedge and lespedeza. Areas in pasture for several years generally have a notable quantity of brushy and weedy growth on them. Under average management, corn yields about 25 bushels, wheat about 12 bushels, and lespedeza hay about 0.7 ton an acre.

Plant nutrients, nitrogen, phosphorus, potassium, lime, and organic matter are the chief requirements for establishing and maintaining a high productivity, although some attention should be given to controlling runoff on the more sloping parts. If the fertility and organic-matter content is maintained at a high level, relatively short rotations including moderately frequent row crops are feasible. Red clover, timothy, white clover, and bluegrass are suited to this soil where it is maintained in a productive condition, and pastures of good quality are feasible with proper fertilization, seeding, and brush and weed eradication. If properly managed, this soil produces about 35 bushels of corn, 20 bushels of barley, and 1.5 tons of red clover and timothy hay.

Leadvale silt loam, sloping phase.—Differing from the type in having a more sloping surface (5 to 15 percent), this soil consists of local alluvial-colluvial material washed from Lehew, Muskingum very fine sandy loam, Montevallo, and Armuchee soils, the parent rocks of which were predominantly shale. Although most areas lie on gentle slopes at the foot of hilly and steep areas, some lie as narrow strips along drains that extend into areas of these hilly and steep soils. Internal drainage is fair to good. This phase is a little less favorable for crops than is that of the Jefferson soils. Many of the areas are adjacent to Lehew soils in Crackerneck Valley along the southeast edge of Log Mountain.

There are a few areas along the southeast edge of Poor Valley Ridge. Most of the areas are small and associated with extensive steep soils poorly suited to crops. The native vegetation was chiefly oak and other deciduous hardwoods, with some shortleaf pine intermixed.

Following is a profile description of this phase:

0 to 7 inches, brownish-gray mellow silt loam.
7 to 26 inches, yellow or yellowish-brown firm silty clay loam.
26 inches +, moderately mottled yellow, gray, and brown silty clay loam, a little more friable than the layer above. Bedrock generally is at a depth of more than 30 inches and may be more than 10 feet.

This soil is medium to strongly acid and is low in plant nutrients and organic matter. It is moderately permeable to roots and moisture, although somewhat less so than the soils of the Fullerton and Clarksville series. Infiltration is sufficiently retarded to cause runoff to develop rather easily. Its capacity for holding moisture available to plants is fair. Most areas associated with Lehew soils have a purplish-yellow or reddish-gray color and have many small sandy shale fragments in them.

This soil is suited to crops and pasture but its use is somewhat restricted by its low fertility and moderately strong slope. Because of this slope, it is not so easily worked as the type, and runoff is difficult to control when the soil is not well protected by a close-growing cover.

Practically all this soil has been cleared and most of it is now used for either crops or pasture. About 25 percent is used for corn, 25 percent for small grains, and the rest for hay and pasture. Light applications of about 150 pounds of mixed fertilizers are commonly used for wheat and for some corn, and lime may have been applied to a small acreage. Very little barnyard manure is used, and green-manure crops are seldom grown. Mixed lespedeza and redtop are the chief hay crops, and pasture consists chiefly of broomsedge and lespedeza. Areas in pastures for several years generally have a notable quantity of brushy and weedy growth on them. Some areas that became unproductive and eroded are classed as unimproved pasture for a period of years, after which they are again cropped. Under average management, corn yields about 20 bushels, wheat about 9 bushels, and lespedeza about 0.6 ton an acre.

Careful management is required if it is to be maintained in a productive state. Long rotations consisting chiefly of fall-sown small grains, hay, and pasture crops should be used mainly for the purpose of keeping tillage at a minimum and keeping the soil protected against erosion. A rotation consisting of a row crop, 1 or 2 years of small grain, and several years of hay or pasture is suited to it. Substantial applications of complete fertilizer, lime, and organic matter are required to develop a high productivity. Where barnyard manure is not available in sufficient quantities, legume green-manure crops probably should be used. Pasture and hay respond well to phosphorus and lime. Where the fertility is brought to a high level, red clover, timothy, white clover, bluegrass, and possibly alfalfa are suited. Otherwise lespedeza, redtop, and orchard grass are to be preferred for hay and pasture.

Cultivation and other field operations should be on the contour as

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much as is feasible, and strip cropping, terracing, and other mechanical means of water control may be feasible in places. Under good management, corn yields about 30 bushels, barley 18 bushels, and lespedeza about 1.1 tons an acre.

Lehew stony very fine sandy loam.—A somewhat purplish shallow steep soil predominating on Log Mountain, developed from interbedded acid sandstone and shale of the Rome geologic formation. Although much of the parent rock has a purplish tinge, other parts are more brown or yellow. Due to the variations in the parent rock, the nature of the soil also varies. The surface is steep (30 to 60 percent). Internal drainage is good. This is a fairly extensive soil on Log Mountain and War Ridge. A smaller area is on Lone Mountain. Practically all is in large bodies. The native vegetation was mixed deciduous hardwoods and shortleaf pine.

A profile description is as follows:

0 to 10 inches, somewhat purple or reddish-gray mellow very fine sandy loam, containing numerous fine-grained sandstone and shale fragments.

10 to 20 inches, purplish-brown or weak-red slightly firm but friable fine sandy clay containing numerous fine-grained sandstone and shale fragments.

20 to 24 inches, a mixture of sandstone and shale fragments and some soil material predominantly yellow splotched with weak red, brown, and gray. Bedrock fine-grained sandstone or shale is below.

In some places the soil is more yellow, and the content of rock fragments varies. The thickness of the surface layer and depth to bedrock also vary. Very little of it, however, has a depth of more than 30 inches. A fairly small area has lost more than 50 percent of its surface soil by erosion and a part has lost all the surface soil and a part of the subsoil. Gullies are common on the most severely eroded areas.

The soil is strongly acid and low in plant nutrients and organic matter. It is easily permeable to both roots and water but due to its shallowness, its capacity for holding moisture available to plants is small.

The soil is poorly suited to crops and to pasture. Its productivity is low, and, because of its steep slope and stoniness, it is difficult to work. Because of the steep slope and the difficulty of maintaining a good vegetative cover, runoff is hard to control.

Most of the land is in forest and has never been completely cleared. Much of the cleared area has been cultivated at sometime but is now used as unimproved pasture, only a small acreage being cropped. Yields are low, and the quality of the pasture is only fair. Better pasture may be expected where lime and phosphorus are applied. Grazing vegetation is more luxuriant and more persistent on the north-facing slopes in dry seasons. In general this soil is better used as forest than for crops.

Lehew stony very fine sandy loam, eroded hilly phase.—Differs from the type and has a hilly rather than steep slope. It is developed from interbedded acid sandstone and shale of the Rome geologic formation. Although much of the parent rock is somewhat purple, other parts are more brown or yellow. Due to variations in the parent

rock, the soil is also somewhat variable. The surface is strongly sloping or hilly (12 to 30 percent) (pl. 5, *B*). Internal drainage is good, and practically all areas are moderately or severely eroded. Practically all this soil is on the lower part of the southeast slope of Log Mountain. The native vegetation was predominantly oak, other deciduous hardwoods, and shortleaf pine.

Following is a description of a profile of an eroded purplish section, which represents the predominant acreage of this soil:

0 to 4 inches, purplish-gray or weak-red loose friable sandy clay, containing a large quantity of fine-grained sandstone and shale fragments.

4 to 15 inches, purplish-yellow or weak-red somewhat firmer but friable sandy clay loam, containing numerous fine-grained sandstone and shale fragments.

15 to 20 inches, a mixture of sandstone and shale fragments and some soil material, predominantly yellow splotched with weak red, brown, and gray, overlying bedrock of fine-grained sandstone or shale.

In some places the soil is yellower, and the content of fragments varies. The thickness of the surface layer varies according to the quantity of erosion. In abandoned areas, the 4-inch surface layer is frequently lacking. On the other hand about 100 acres, which has never been tilled, has a surface layer about 10 inches thick of reddish-gray fine sandy loam, containing numerous fine-grained sandstone and shale fragments. Another 100 acres or so is moderately eroded and has a surface layer similar to the above but only 5 or 6 inches thick.

A large part of the predominant eroded acreage has gullies in it, many of which are difficult or impossible to cross with farm machinery. Most of these are represented on the map by appropriate symbols.

This soil is strongly acid and low in plant nutrients, lime, and organic matter. It is permeable to roots and moisture, but infiltration or absorption of water for most of it is slower owing to the absence of the more open surface layer. Its moisture-holding capacity is fair to poor.

This soil is poorly suited to crops and pasture. Its productivity is low and chiefly because of its strong slope, eroded condition, and stoniness, it is difficult to work and conserve. Except the smoother and less eroded areas, this soil is best suited to forest.

About 85 percent of the soil has been cleared and cropped. Of this about 35 percent is abandoned to unimproved pasture or reforested, about 40 percent is used for hay and improved pasture, and about 10 percent for other crops, chiefly corn.

Little fertilization is practiced, and little lime has been used. Yields of all crops are low, and the quality of pasture is only fair. Better hay and pasture, especially on the smoother less eroded parts, can be expected where lime and phosphorus are applied.

Limestone outcrop.—This land type consists of areas in which limestone outcrops and fragments are so abundant as to make them very nearly worthless as pasture. Soil material, which is predominantly Talbott, occupies less than 25 percent of the surface. The outcrops protrude from 1 to 3 or 4 feet. The surface has a slope of 3 to more than 30 percent. About a fourth of the land type has a slope of more

than 30 percent, mostly in the vicinity of Hinds and Copper Ridges. A small area has a slope of less than 15 percent, most of which is in Clinch Valley with a smaller acreage in Richland Valley. The rest has a slope of 15 to 30 percent, much of which is in Clinch and Richland Valleys. The native vegetation apparently included much cedar and smaller quantities of locust, walnut, and other deciduous trees.

This land type is not suited to crops and is very poorly suited to pasture, because of the lack of sufficient soil material to grow an appreciable quantity of grass or other plants. Some of the smoother cleared areas afford poor pasture. The rougher areas are practically all forested with an irregular stand of deciduous hardwoods and cedars. Redcedar predominates on the smoother forested areas.

Lindside silt loam.—An intermediately drained soil on creek bottoms in areas of soils developed from high-grade and argillaceous limestone. It consists of material washed chiefly from Talbott, Colbert, Dewey, Decatur, and associated soils, including some developed from interbedded limestone and shale.

The surface is nearly level, and all areas are subject to overflow. Internal drainage is poor, the subsoil being waterlogged during wet periods. Most areas lie as strips occupying the creek bottoms in the limestone valleys, chiefly Richland and Clinch Valleys. Some of the acreage in Richland Valley and along the Holston River was inundated by the Cherokee Reservoir. The native vegetation was moisture-tolerant oak, elm, maple, and other deciduous hardwoods.

A profile description is as follows:

0 to 16 inches, grayish-brown or light yellowish-brown mellow silt loam.

16 to 40 inches, mottled gray and light yellowish-brown firm silt loam.

40 inches +, predominantly gray with some yellow and brown mottlings. Bedrock is at a depth of several feet.

Some areas along Indian and Richland Creeks have been influenced sufficiently by material brought from shale areas to have a few shale fragments in them and the few areas in the Holston River Valley have some sand in them.

This soil is very fertile, is slightly acid to neutral, and contains a fair quantity of organic matter. Although internal drainage is slow, it is permeable to roots and moisture. Throughout most of the growing season moisture relations are favorable except for alfalfa, tobacco, certain truck crops, and some seasons for small grains.

The soil is productive, but its suitability is limited chiefly to corn and certain hay and pasture plants. The water table is too high for alfalfa, small grains commonly lodge, and excessive moisture conditions are too frequently a hazard for tobacco and truck crops. Excessive moisture commonly interferes with tillage and other field operations; otherwise, it is not difficult to work. Because of its ability to hold plant nutrients, its periodic inundation, and nearly level surface, its conservation requires little effort.

Practically all this soil is cleared and is being used for crops or pasture. About 70 percent is used for corn and most of the rest for hay and pasture. Many fields are used for corn several years in succession and

very little manure or fertilizer is applied. Under average conditions corn yields 35 to 45 bushels and lespedeza hay about 1.3 tons an acre. Excessive moisture damages the corn crop 1 or 2 years out of 10. Yields of corn and hay probably could be increased some by moderate applications of a mixed fertilizer and artificial drainage. The feasibility of drainage, however, must take into account such factors as possible drainage outlets and the cost per acre of installing the system. The soil is desirable for pasture. The vegetation, chiefly bluegrass and white clover, is abundant and of good quality. Moisture relations are more favorable for sustaining midsummer grazing than for most other soils of the county.

Melvin silt loam.—Occurring on the first bottoms, this light-colored, poorly drained soil consists of material washed from Talbott, Colbert, Dewey, Decatur, and associated soils, but a few areas consist of material washed chiefly from Fullerton, Bolton, and Clarksville. It is in areas of soils developed over limestone. Most areas occupy slight depressions on the nearly level creek bottom lands and are easily subject to overflow. Internal drainage is poor and during wet periods, the entire soil is waterlogged and may have standing water on it. The separate areas are small and widely distributed throughout those parts of the county underlain by limestone, principally in Richland and Clinch Valleys.

A profile description is as follows:

0 to 7 inches, medium gray, with small yellow and brown mottlings, mellow silt loam.

7 to 30 inches +, predominantly medium gray mottled with yellow moderately compact silty clay loam or silty clay. In some parts there is very little or no mottling. Bedrock is at a depth of several feet.

Some areas have a surface layer 2 to 5 inches thick of a browner silt loam that is recent alluvium. This type is slightly acid to neutral, is moderate to low in fertility, and apparently very low in organic matter. It is slowly permeable to roots and moisture.

This type is poorly suited to crops and is fair to good pasture land. For most crops its productivity is poor, and, because of its very slow drainage, it is difficult to work. Its moisture relations favor it for midsummer and fall grazing, the seasons when upland pastures are generally dormant due to lack of moisture. Adequate artificial drainage and fertilization may make this soil well suited to corn and certain hay crops.

Most of this soil is cleared and used for pasture and hay. Fertilization is seldom practiced, and crops are not rotated. The quality of hay is fair, but pasture varies from poor to good. Good pasture probably cannot be obtained on the wettest areas without artificial drainage but on the less wet areas fertilization with phosphorus probably would improve it. Mowing the weeds will do much towards improving the quality and quantity of grazing on all areas. Areas artificially drained and properly fertilized should be very productive of corn and hay.

Montevallo shaly silt loam, eroded undulating phase.—This phase has a smooth or undulating surface, the gradient being less than 5 percent. About two-thirds of the acreage has been moderately eroded, 50 to 75 percent of the surface soil having been lost by erosion. This

soil was developed from acid shale of the Rogersville geologic formation. Internal drainage is good. Most of the aggregate area lies as narrow strips associated with the more productive soils in Richland Valley. The native vegetation was predominantly deciduous hardwoods, chiefly oak.

A profile description is as follows:

0 to 5 inches, brownish-yellow or pale-brown mellow shaly silt loam.
5 to 14 inches, brownish-yellow or pale-brown shaly silty clay, overlying beds of grayish-yellow or bluish-gray fissile shale.

About a third of the acreage is not materially eroded, and here the surface layer is 2 or 3 inches thicker. A part of this less eroded acreage is a little less shaly, and the shale beds are about 25 inches below the surface. This soil is strongly acid and low in plant nutrients and organic matter. It is permeable to roots and moisture, but its moisture-holding capacity is only moderate.

This soil is fair cropland and fair pasture land. Its productivity is low, but it is easy to work and to conserve. It is suited to most general farm crops but not to intensive use, because of its low fertility and the ease with which it is injured by relatively little erosion.

Practically all the acreage has been cleared, and most of it is now used for crops and pasture. About 20 percent is used for corn and tobacco, 60 percent for hay and pasture, and about 20 percent for small grains and other crops. The management practiced varies greatly; some areas are fertilized moderately, whereas others receive little. Those farmed in conjunction with other more productive soils in general receive the best treatment. The length of rotation is likewise variable, but most areas are used in a 3- or 4-year rotation. Under a system of management including some commercial fertilizer and barnyard manure, corn yields 12 to 20 bushels, wheat 6 to 10 bushels, and lespedeza 0.4 to 1 ton an acre. The chief fertilizer requirements are phosphorus, nitrogen, lime, and organic matter. Where a high state of fertility is maintained, moderately productive pasture of good quality can be maintained through the growing season except during the driest summer and early fall period.

Montevallo shaly silt loam, eroded rolling phase.—Differs from the severely eroded phase in having a less steep slope and in being somewhat less eroded. This gray thin shaly soil is developed over acid shale. The average slope ranges from 5 to 12 percent, and most of the areas are moderately rather than severely eroded. Internal drainage is good. The soil is developed from acid shale of the Rogersville geologic formation. Most of it is in Richland Valley. The separate areas are narrow strips, many being closely associated with productive soils, as those of the Hayter, Emory, and Decatur series. The native vegetation was predominantly hardwood, chiefly oak.

A profile description is as follows:

0 to 4 inches, brownish-yellow or pale-brown mellow shaly silt loam.
4 to 12 inches, brownish-yellow or pale-brown shaly silty clay, underlain by beds of grayish-yellow or bluish-gray fissile shale.

Approximately one-fifth of the acreage of this soil is under cut-over

forest and is not materially eroded. Here the surface soil is 6 to 8 inches thick. This soil is strongly acid and is low in plant nutrients and organic matter. It is permeable to roots, but its moisture-holding capacity is small and consequently the soil is droughty.

In general this soil is poorly suited to crops and pasture, although a few acres where the soil material is thicker than average and less shaly are fair cropland. In general its productivity is low, and it is easily damaged by erosion, due to the shallow depth to the shale beds.

More than 80 percent of this soil has been cleared and used for crops or pasture. About 20 percent of the total area is used for corn, about 20 percent for small grains, and about 30 percent for hay and pasture. The rest is unimproved pasture. Some fertilizer, including barnyard manure, is probably used on a part of it, especially the narrower strips that are closely associated with and therefore managed along with more productive soils. Under average conditions corn yields about 10 bushels and lespedeza hay about 0.3 ton an acre. Where lime, organic matter, and phosphorus are applied in ample quantities about 0.9 ton an acre is produced on the more favorable areas. Areas of this soil for crops and pasture should be used only in a long rotation, consisting chiefly of permanent pasture due to the erosion hazard, the limited moisture-holding capacity, and the difficulty of maintaining a relatively high productivity.

Montevallo shaly silt loam, eroded hilly phase.—This phase differs from the shaly silty clay loam, severely eroded phase, in having a less steep slope and in being less uniformly severely eroded. The slope ranges from 12 to 30 percent and about half the acreage has all or some of its original surface layer. This soil is developed from acid shale of the Rogersville geologic formation. Most of it is in the valley at the southeast base of Log Mountain. There are a few small areas in Richland Valley. The native vegetation was oak and other deciduous hardwoods.

A profile description is as follows:

0 to 4 inches, brownish-gray or pale-brown mellow shaly silt loam.
4 to 12 inches, brownish-yellow or very pale-brown shaly silty clay, underlain by beds of grayish-yellow or bluish-gray fissile shale.

In a very small acreage that has not been cleared, accelerated erosion has not been great. In these areas the surface layer is 6 to 8 inches thick. Where the acreage is severely eroded, the surface layer consists of brownish-yellow or very pale-brown shaly silty clay, underlain at a depth of about 8 inches by beds of shale. Gullies are common though not numerous in the severely eroded areas, and a few are in most of the moderately eroded areas. The larger ones are indicated by appropriate symbols on the soil map. This soil is strongly acid and low in plant nutrients and organic matter. It is permeable to roots and moisture, but the moisture-holding capacity is small and consequently the soil is droughty.

The soil is poorly suited to crops and pasture. The productivity is low, and because of its strongly rolling surface, shaly nature, and shallow depth to bedrock, the land is difficult to work and conserve.

Nearly all of this soil has been cleared and used for crops or pasture but about 70 percent has been abandoned to forest or unimproved

pasture. Most of the rest is used for hay and improved pasture. A very small quantity of corn, wheat, and tobacco is raised. Yields of these crops are low. The less steep and less eroded areas are suitable for pasture, providing they are fertilized sufficiently to support a good cover. Phosphorus and lime are the chief amendments needed but organic matter and nitrogen are also low. Under average conditions lespedeza, redtop, and orchard grass are the best hay and pasture plants. Where the fertility is brought to a high level, bluegrass and white clover may be an important part of the grazing vegetation. Some care needs to be taken to avoid the development of small gullies and sheet erosion by overgrazing, and weedy and bushy growth requires mowing to keep it from encroaching on the pastures.

Montevallo shaly silty clay loam, severely eroded rolling phase.—This phase has an undulating to rolling surface (5 to 12 percent) that has been severely eroded. It is developed from acid shale of the Rogersville geologic formation. Practically all the surface soil and in places part of the subsoil have been lost by erosion. Internal drainage is good. Most of this phase lies as narrow strips associated with the more productive soils in Richland Valley. The native vegetation was predominantly deciduous hardwoods, chiefly oak.

Following is a profile description of this phase:

0 to 8 inches, brownish-yellow or very pale-brown mellow shaly silty clay, underlain by beds of grayish-yellow or bluish-gray fissile shale.

In general this soil is poorly suited to crops and pasture. Its productivity is low, and its workability and conservability are poor. Many areas are probably best suited to forest. All this soil has been cleared, but a considerable part has been abandoned to volunteer forest or unimproved pasture. A small acreage, especially that in narrow strips associated with productive soils, is used for crops. Except where heavy fertilization has been practiced, crop yields are low. Under average management, which includes little fertilization and no cover crops other than small grains, corn yields are less than 10 bushels an acre and lespedeza hay less than 0.3 ton. Areas required for crops and pasture should be used in a very long rotation consisting chiefly of permanent pasture.

Montevallo shaly silty clay loam, severely eroded phase.—A gray thin shaly soil developed over acid shale most of which is of the Rogersville geologic formation. The surface is steep (30 to 60 percent). A large part of the soil has been severely eroded. Practically all the surface soil, and, in most places, a part of the underlying material have been lost. Gullies are common. Internal drainage is good. Most of this phase is on the lower slopes of Log Mountain and in the vicinity of Bald Point. The native vegetation was predominantly deciduous hardwoods, chiefly oak.

A profile description is as follows:

0 to 8 inches, brownish-yellow or very pale-brown mellow shaly silty clay, overlaying beds of grayish-yellow or bluish-gray fissile shale.

In places the texture of the surface layer is shaly silt loam. On the

other hand where the shale fragments are very abundant there is hardly enough soil material to support any vegetation. Few gullies are more than 2 feet deep, but most of them are not easily crossed by farm machinery. The larger ones are indicated on the soil map by appropriate symbols.

This soil is very poorly suited to crops and pasture. Its productivity is low, and because of its steep slope, shaly nature, and very shallow depth to bedrock, it is difficult to work and conserve. Nearly all this soil has been cleared and cropped at sometime, but practically all of it has been abandoned to forest or unimproved pasture. Pine forest is the best use to which it is suited.

A small acreage is included with this phase that has never been cleared. Here the 6-inch surface layer is brownish-gray or pale-brown shaly silt loam. The soil is strongly acid and low in plant nutrients, lime, and organic matter. It is permeable to roots and moisture, but the moisture-holding capacity is small and consequently the soil is droughty.

Muskingum very fine sandy loam.—A shallow gray soil predominating on the steep slopes of Poor Valley knobs. It is developed over acid shale interbedded with fine-grained sandstone of the Grainger geologic formation. The surface is steep (30 to more than 50 percent). The slopes are long, and most surface drainage is to rather precipitous drainageways that are at right angles to the general lay or direction of Poor Valley Ridge. Internal drainage is good. This is the most extensive soil of Grainger County. It is confined almost wholly to Poor Valley Ridge. The separate areas are very large throughout. The native vegetation was predominantly yellow pine with some oak intermixed.

A profile description is as follows:

0 to 8 inches, yellowish-gray friable very fine sandy loam, containing a few shale fragments.
8 to 18 inches, yellow or light yellowish-brown friable very fine sandy clay loam, with some shale fragments intermixed.
18 inches +, splotched or mottled yellow, gray, and brown friable fine sandy clay loam, containing many shale fragments. Bedrock of fine-grained sandstone is at a depth of about 26 inches.

The soil is strongly acid and low in plant nutrients and organic matter. It is permeable to roots and moisture, but runoff is very rapid. Because of its steep slope, shallow depth to bedrock, and low fertility, this soil is very poorly suited to pasture. Its workability is poor, and it is difficult to conserve against losses by runoff. All this soil is in forest and practically all of it has been cut-over. Forest is the use to which it is best suited, although with heavy fertilization and liming some of the less steep areas may afford fair to good grazing.

Included with this soil are a few areas that are less steep, but they are too small to justify delineating them separately on the map.

Muskingum very fine sandy loam, eroded phase.—This soil differs from the type in being appreciably eroded. Less than half of the acreage has lost 50 to 75 percent of the surface soil, and the rest has lost practically all of it and in places a part of the subsoil. This phase is

developed over acid shale interbedded with fine-grained sandstone. The surface is steep, the gradient ranging from 30 to more than 50 percent. Internal drainage is good. The separate areas are irregular and represent areas of the type that have been tilled. Practically all this soil is on Poor Valley Ridge. The native vegetation was predominantly yellow pine with some oak intermixed.

A profile description is as follows:

0 to 14 inches, yellow or light yellowish-brown friable very fine sandy clay loam with some shale fragments.

14 inches +, splotched or mottled yellow, gray, and brown friable fine sandy clay loam, containing many shale fragments. Bedrock fine-grained sandstone is at a depth of about 20 inches.

The above describes the more eroded parts. Where erosion has been somewhat less severe, the plow layer consists of a mixture of material of the original surface soil and of the subsoil. The soil is strongly acid and low in plant nutrients and organic matter. It is permeable to plant roots and moisture but is easily damaged by erosion.

This soil is poorly suited to crops and to pasture. Its productivity is low, and because of its strong slope it is difficult to work. The shallow depth to bedrock, the strong slope, and the low fertility make its conservation difficult when tilled.

All this soil has been cleared but about half of it has been abandoned to forest. Much of the remaining part is used as unimproved pasture. A small acreage is used for corn. A small quantity of fertilizer is used for this crop, but yields are very low.

Most of the soil is best used for forest, although the less steep and more favorably located areas may be suitable for pasture if adequately fertilized and limed. Unless the fertility is raised to a high level, lespedeza and redtop are probably among the better suited pasture crops.

Muskingum very fine sandy loam, hilly phase.—This soil consists of areas of the type that have a less steep slope (12 to 30 percent). It is developed over acid shale interbedded with fine-grained sandstone. Internal drainage is good. The areas are moderate size and most of them are along the base of the main Poor Valley Ridge. The native vegetation was chiefly yellow pine, with some oak intermixed.

A profile description is as follows:

0 to 8 inches, yellowish-gray friable very fine sandy loam, containing a very few shale fragments.

8 to 22 inches, yellow or light yellowish-brown friable very fine sandy loam.

22 inches +, splotched or mottled yellow, gray, and brown friable very fine sandy clay loam, containing many shale fragments. Bedrock fine-grained sandstone is at a depth of about 30 inches.

The soil is strongly acid and low in plant nutrients and organic matter. It is permeable to roots and moisture but runoff is rapid. Because of its low fertility and shallow depth to bedrock, the soil is poorly suited to crops and pasture. Yields are low, and the soil is difficult to work and conserve. Those areas having more favorable exposure (predominantly north-facing slopes) and greater depth to bedrock may be suitable for grazing when properly fertilized.

Practically all this soil is in forest to which it is best suited. If fertilized, particularly with phosphorus and lime, the more favorable areas will produce fair to good pasture. Lespedeza and redtop are among the better suited pasture plants, although some bluegrass and white clover may be expected on the most favorable parts.

Muskingum very fine sandy loam, eroded hilly phase.—Includes areas of the type that have a less steep slope and that have been moderately to severely eroded. About half of this phase has lost from 50 to 75 percent of the surface soil, and the rest has lost practically all the surface soil and in places a part of the subsoil as a result of erosion.

About two-thirds of the acreage is developed over acid shale interbedded with fine-grained sandstone of the Grainger formation, and the rest is developed over sandstone of the Clinch formation. The surface is hilly, the slope ranging from 12 to 30 percent, and internal drainage is good. Practically all of it is on the lower part of the southeast slope of Poor Valley Ridge. The native vegetation was predominantly yellow pine, with oak intermixed.

A profile description of this hilly phase, where erosion has removed practically all the surface soil, is as follows:

0 to 15 inches, yellow or light yellowish-brown friable very fine sandy clay loam with some shale fragments.

15 inches +, splotched or mottled yellow, gray, and brown friable very fine sandy clay loam, containing many shale fragments. Bedrock fine-grained sandstone is at a depth of about 20 inches.

Where erosion has been somewhat less severe, the plow layer consists of a mixture of the original surface soil (yellowish-gray friable very fine sandy loam) and of the subsoil. The soil is strongly acid and low in plant nutrients and organic matter. It is permeable to plant roots and moisture, but is easily damaged by erosion and has only a fair capacity for moisture available to plants.

Because of the low productivity and the difficulty in maintaining a moderately high level, the soil is difficult to work and is poorly suited to crops and fair to poorly suited to pasture. Because of its shallow depth to bedrock and strong slope, it is difficult to conserve from losses by runoff. Unless requirements for pasture and cropland are very pressing, this soil is best used for forest.

Practically all this soil has been cleared, but about 30 percent has been abandoned to unimproved pasture or forest. About 60 percent is used for hay and pasture and about 10 percent for other crops, chiefly corn. Little fertilization is practiced and yields of hay, corn, and pasture are very low. Areas to be used for pasture should be treated with at least lime and phosphorus. If heavy applications of fertilizer including organic matter are made, bluegrass and white clover may be suitable for pasture on the more favorable sites, otherwise lespedeza, redtop, and orchard grass are more suitable for grazing.

Included with this soil are a few areas of Hector stony fine sandy loam, hilly phase, which have a grayish-yellow stony fine sandy loam surface soil about 8 inches thick and a yellowish-red friable fine sandy clay subsoil. Bedrock sandstone is at a depth of about 30 inches.

Muskingum stony fine sandy loam.—This shallow gray soil is de-

veloped over sandstone and contains numerous sandstone fragments, whereas the very fine sandy loam and its phases are developed over acid shale interbedded with fine-grained sandstone and are relatively stone-free except for the limited included areas on Clinch Mountain. The surface is steep (30 to 60 percent or more). Internal drainage is good. This types occurs in large areas on the southeast slope of Clinch Mountain. The native vegetation was yellow pine, with some oak intermixed.

A profile description is as follows:

0 to 10 inches, yellowish-gray friable fine sandy loam containing numerous sandstone fragments, 3 to 12 inches in diameter.

10 to 22 inches, light yellowish-brown to weak-yellow friable fine sandy clay loam or fine sandy clay.

22 inches +, splotched or mottled yellow, gray, and brown friable sandy clay loam, containing numerous sandstone fragments. Bedrock is at an average depth of 26 inches, but in places it is at a much shallower depth and outcrops are not uncommon.

The soil is strongly acid and low in plant nutrients and organic matter. It is permeable to roots and moisture, but its capacity for holding moisture available to plants is small. Because of low fertility, droughty nature, stoniness, and steep slope, this soil is poorly suited to crops and to pasture, although some parts on the more northerly facing slopes may be capable of affording an appreciable quantity of grazing where sufficient effort is made to establish a grazing vegetation.

All this soil is under forest, and practically all has been cut-over. The small acreage that may be suitable for grazing requires treatment with phosphorus and lime. In general, this soil should be used only for forest, and yellow pine is one of the best suited species.

Muskingum stony fine sandy loam, hilly phase.—Areas of the type with a slope of not more than 30 percent are represented by this soil. It is developed over sandstone of the Clinch geologic formation. Internal drainage is good. The area is small compared with that of the type, and the separate areas are inextensive. Nearly all of it is on the lower part of the southeast slope of Clinch Mountain. The native vegetation was yellow pine with oak intermixed.

A profile description is as follows:

0 to 10 inches, yellowish-gray friable fine sandy loam, containing numerous sandstone fragments, 3 to 12 inches in diameter.

10 to 25 inches, light yellowish-brown to weak-yellow friable fine sandy clay loam or fine sandy clay.

25 inches +, splotched or mottled yellow, gray, and brown friable sandy clay loam, containing numerous sandstone fragments. Bedrock sandstone is at a depth of 28 inches, but in places it is at a much shallower depth and outcrops are common.

This phase is medium to strongly acid and low in plant nutrients and organic matter. It is permeable to roots and moisture but runoff is rapid, and much of the soil, especially on the more southerly slopes, is droughty.

Because of its low fertility, stoniness, and shallow depth to bedrock, this soil is poorly suited to crops and to pasture. Yields are low, and

it is difficult to work and conserve. Those areas having the more favorable exposures (principally north-facing slopes) and greater depth to bedrock may be suitable for grazing when properly fertilized.

Practically all this soil is under forest, to which use it is probably best suited. If fertilized with phosphorus and lime, the more favorable areas will produce fair to good pasture. Lespedeza and redtop are among the better suited pasture plants, although some bluegrass and white clover can be expected on the most favorable parts.

Included with this soil are a few areas of Hector stony fine sandy loam, hilly phase, the acreage of which is too small to show separately on the map. These areas have a surface layer of grayish-yellow stony fine sandy loam about 8 inches thick underlain by yellowish-red friable fine sandy clay. Bedrock sandstone is at a depth of about 28 inches.

Ooltewah silt loam.—This nearly level imperfectly drained soil occurs in sinks and depressions, is associated with soils developed over limestone, and consists of local alluvium washed from the Fullerton, Bolton, and Clarksville soils. The surface is nearly level or saucer-like, and very few areas have surface drainage outlets. Internal drainage is slow. All the areas are small, few exceeding 5 acres. They are infrequent but are widely scattered through the county.

A profile description is as follows:

0 to 16 inches, grayish-brown mellow silt loam.
16 to 30 inches, mottled gray, brown, and yellow friable silt loam or silty clay loam.
30 inches +, predominantly gray mottled with brown and yellow friable silt loam or silty clay loam. Bedrock limestone is generally below a depth of several feet.

The degree of internal drainage and the depth below which the material is mottled vary appreciably from place to place as does also the thickness of very recently accumulated alluvium. In many places where accelerated erosion has been active on the surrounding soils of the upland, a weak-yellow silt loam layer, 4 to 12 inches thick, overlies the darker original surface layer described above.

The soil is slightly to medium acid, and its natural fertility is moderately high. It is permeable to roots, but moisture infiltration is notably retarded and root penetration by plants requiring good drainage is restricted. It is capable of holding a large supply of moisture available to plants and this, combined with its position and slow internal drainage, give it particularly favorable moisture relations for growing plants in late summer and early fall. The native vegetation was probably moisture-tolerant deciduous hardwood species.

This soil is well suited to many crops requiring tillage and very well suited to pasture. Its productivity for crops that respond to or can tolerate abundant moisture is high. The workability is good, although less favorable than for some soils due to the slowness with which moisture conditions become suitable for cultivation in spring and following periods of precipitation. The conservability is very good inasmuch as plant nutrients are retained well and runoff is not active. Corn, certain hay crops, and many pasture plants are well suited to this soil.

Practically all this soil has been cleared and is being used for crops and pasture. About 30 percent is used for corn, and most of the rest

for hay and pasture. Very little small grain and tobacco are grown and no alfalfa. A few areas, especially those associated with stony land types, are used as permanent pasture, but a great many areas are used in a short rotation of corn and hay. Some fertilization is common for the corn crop but little is used for hay. Under average management yields are moderately high, but occasionally they are damaged by excess moisture. Corn yields about 35 bushels and lespedeza about 1.3 tons an acre. Yields can be expected to increase appreciably after heavier fertilization and on many areas lime will benefit the legumes. The suitability and general productivity can be increased for many areas by artificial drainage, but such improvement may not be feasible.

Philo fine sandy loam.—This somewhat gray imperfectly drained soil on the first bottoms consists of material washed from soils over sandstone and acid shale. The surface is nearly level, and all areas are subject to overflow. Internal drainage is poor. Most of the areas are narrow strips along the small creeks in Poor Valley and along the northwest edge of Richland Valley, associated with Pope and Atkins fine sandy loams. The native vegetation was moisture-tolerant deciduous trees.

A profile description is as follows:

0 to 16 inches, brownish-gray fine sandy loam.
16 to 30 inches, mottled gray, yellow, and brown firm but moderately friable sandy clay loam or sandy clay.
30 inches +, predominantly gray mottled with yellow and brown firm but moderately friable sandy clay loam or sandy clay.

This soil is strongly acid and is low in plant nutrients and organic matter. It is permeable to roots, but moisture infiltration is notably retarded, and root penetration by plants requiring good drainage is restricted. The soil is capable of holding a fair supply of moisture available to plants and this combined with its slow internal drainage gives it favorable moisture relations for growing plants during late summer and early fall.

The soil is fairly well suited to crops and pasture. Its natural productivity is low, it is suited only to certain crops, and its workability is not good because of excess moisture conditions in spring and following periods of precipitation. Its conservability is fairly good, although a high level of fertility evidently requires consistent heavy fertilization.

About 80 percent of the soil is cleared and used for corn, hay, and pasture. Some barnyard manure or fertilizer is used for corn, and some lime may have been applied. The length of rotation varies greatly, some areas being used for permanent meadow or pasture, whereas others are used intensively for row crops. Under average management yields are only fair. Corn yields about 20 bushels and lespedeza about 0.6 ton an acre. Alfalfa, tobacco, and potatoes are not well suited to the soil, but with adequate fertilization, red and alsike clovers, timothy, bluegrass, and white clover can be expected to yield well. Phosphorus and lime are the chief amendments required for higher yields, but the content of nitrogen, potassium, and organic matter are low and they must be added if a high productivity is to be obtained. The suitability and productivity can be greatly increased for most

areas by artificial drainage; however, such improvement may not be feasible.

Pope fine sandy loam.—This well-drained soil of the first bottoms consists of material washed from soils over sandstone and shale. The surface is nearly level or gently undulating, and all areas are subject to stream overflow, although in general not so much so as are the associated areas of Philo and Atkins soils. Internal drainage is good. Most areas lie as strips, about 300 feet wide, along the stream channels within Poor Valley and along streams flowing from Poor Valley and Poor Valley Ridge to Richland Valley. The native vegetation was predominantly deciduous hardwoods.

A profile description is as follows:

0 to 8 inches, grayish-brown or light yellowish-brown friable fine sandy loam.
8 to 30 inches, brownish-yellow fine sandy loam.
30 inches +, mottled yellow gray and brown fine sandy loam that in general is coarser than the material above. In places the subsoil is a little firmer and contains a little more clay than the surface soil.

This soil is moderately acid, and its natural fertility is fair to moderate. It is very permeable to roots and moisture, and its moisture-holding capacity is fair. In general moisture relations are favorable for most crops, at least for those having a root system extending to a depth of 3 feet.

This soil is well suited to crops and pasture. Its productivity is moderate, it responds well to fertilization, and it is easily worked and conserved. Flooding is a hazard to practically all crops, otherwise the soil is suited to a wide variety of crops.

About 90 percent of the soil is cleared and used for crops and pasture. About 60 percent is used for corn, about 20 percent for hay and pasture, and the rest for small grains and truck crops. Short rotations are practiced, and legumes other than lespedeza are seldom grown. Small grains and corn receive light applications of fertilizer, and some barnyard manure is used on a few areas. Under average management, corn yields about 25 bushels, wheat 10 bushels, and lespedeza 0.9 ton an acre. This soil responds well to good management. A moderate rotation of 3 years including a legume hay crop, as red clover, is well suited but for this crop lime and phosphorus should be added and the organic-matter content increased. If the productivity is to be maintained at a high level, potassium is also required. Green-manure crops, as crimson clover, can do much to increase the organic-matter content where manure is not available. Under a high level of management, corn yields about 40 bushels, wheat 13 to 15 bushels, and red clover and timothy about 1.8 tons an acre.

Roane silt loam.—This well-drained soil of the first bottoms consists of material washed from Fullerton and Clarksville soils. The surface is nearly level or gently sloping, and internal drainage is moderately good. Flooding is not uncommon, but most areas are much less subject to overflow than are other soils on the first bottoms. The soil is widely scattered in the area of Hinds and Copper Ridges and south of Richland Knobs, but the greater part is in the latter. All the areas

occupy narrow bottom lands along the creeks and are therefore dissected by the stream channel. A notable part of the acreage lies as narrow strips adjacent to hilly and steep Clarksville and Fullerton soils, which are poorly suited to tillage and therefore not easily worked. Much of the remaining part is adjacent to rolling and hilly soils, the management requirements of which are notably different from those of this loam. The native vegetation was oak, hickory, and other deciduous hardwoods, with some walnut, sycamore, tuliptree, and others intermixed.

A profile description is as follows:

0 to 12 inches, light-brown or moderate yellowish-brown friable silt loam.

12 to 30 inches, moderate yellowish-brown friable silt loam.

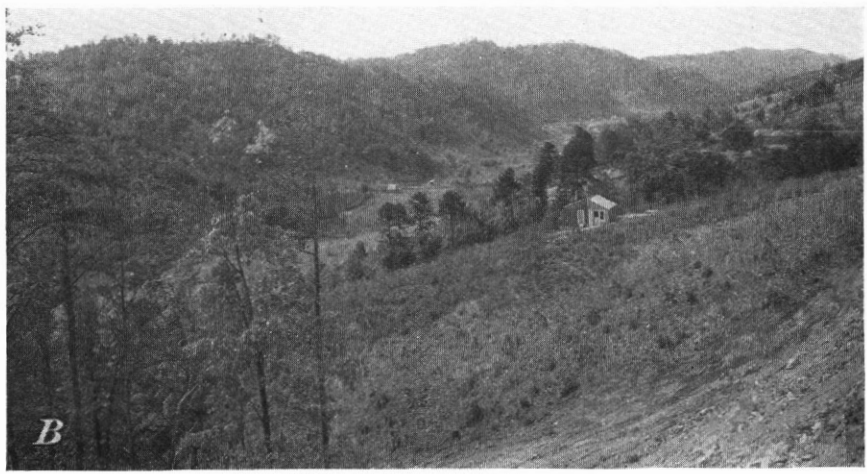
Below this layer, the material is variable. In places there is a semicemented cherty layer 4 to 12 inches thick, below which is a more open matrix of chert and mottled yellow, gray, and brown silt loam. In other places, the cherty layer is lacking and here the mottled yellow and gray silt loam is at a depth of 30 to 40 inches.

Many areas have a moderate quantity of chert throughout their entire depth and in places it is sufficiently abundant to interfere with cultivation. A considerable acreage, however, is free of chert. The color of the surface and subsurface layers is darker brown where a large part of the material has been washed from Bolton soils, and, in general, much of the chert-free acreage is a little darker than the cherty areas.

This type is moderately acid and moderately fertile, but the content of organic matter is not high. The soil is permeable to roots and moisture except where the semicemented cherty layer occurs. This layer, however, is generally at a sufficient depth not to interfere materially with the crops commonly grown. The water-holding capacity is moderate and moisture relations in general are favorable.

Although the usefulness of many areas is restricted by their dissected condition and association with soils not well suited to tillage, this soil is well suited to crops and pasture. The productivity is moderate, tilth is good, and runoff water is not difficult to control.

Most of the soil is cleared and used for crops or pasture. About 50 percent is used for corn, about 30 percent for hay and pasture, and the rest for small grains and other crops. Light applications of fertilizer are used for wheat, and corn generally receives some. Green-manure crops are not commonly grown and only a small quantity of barnyard manure is used. Lime has been applied to some areas. The length of rotation varies widely. Less accessible areas may be used for permanent pasture for several years in succession, whereas other areas are used intensively for row crops, chiefly corn and tobacco. The land for tobacco always receives moderately heavy applications of manure and fertilizer. Under average management, corn yields about 30 bushels, wheat about 12 bushels, and lespedeza about 1 ton an acre. Increased fertilization, the addition of organic matter, and liming can do much towards increasing crop yields and broadening the suitability of this soil. Lime and phosphorus are especially needed where legumes, as red clover, alfalfa, and white clover are to be grown. Where the fertility is maintained at a high level, the soil is suited to relatively short rotations.



A, Extensive areas of Rolling stony land (Talbott soil material) as here illustrated overlie Maryville limestone in Richland Valley. Because of its stony character it is not suited to crops requiring tillage, but most areas are sufficiently productive to support a fairly good grass cover. Pasture on this land type may respond to proper fertilization and seeding.

B, View from Clinch Mountain across Poor Valley to Poor Valley Ridge. The soils of this section, chiefly Muskingum very fine sandy loam on Poor Valley Ridge, Rough stony land (Muskingum soil material) on the near slope, and Jefferson soils in the valley, are developed from sandstone and acid shale. Crop yields are low, and most of the land other than the more arable Jefferson soils is best used for forest.

Landscape in the sandy Fullerton-sandy Clarksville-Bolton association, which is characterized by a bro
severely eroded strong slopes, irregular fields, and a widely divergent land use pattern, ranging

Rolling stony land (Talbott soil material).—Areas of this land type, commonly referred to as rockland or limestone rockland, are characterized by limestone outcrops sufficiently abundant to prohibit feasible tillage (pl. 7, *A*). In most places these outcrops occupy 10 to 50 percent of the surface. The soil material between them resembles that of the Talbott soils. It consists of a few inches of grayish-brown silty clay loam underlain by yellowish-red tough plastic silty clay that may have a fine nut structure. Depth of bedrock limestone is extremely variable but seldom exceeds 3 feet.

The surface is smooth to rolling, the gradient ranging to about 15 percent. All the areas are in limestone valleys. Small sinkholes are abundant, many of which have an accumulation of soil material sufficient to make them very productive. Most of the soil material is fertile, but internal drainage is very slow. Most of this land type is in Clinch and Richland Valleys. The greater part of the Decatur-like variation is in Richland Valley. The native vegetation was predominantly cedar, oak, hickory, locust, and tuliptree.

An extensive variation overlies Maryville limestone and Holston marble and here much of the soil material resembles that of the Decatur soils. The surface layer is brown to dark-brown silty clay loam underlain by red or dark-red dense silty clay. Some of the areas are similar to those of Talbott and Decatur soils that have been eroded sufficiently to expose the underlying bedrock.

Numerous rock outcrops make this soil poorly suited to crops, although the larger patches of soil material are well suited to crops that can be cared for by light horse-drawn and hand implements. Practically all areas are well suited to pasture.

Practically all this land type has been cleared. About 95 percent is used for pasture and the rest for crops. Many of the small sinks with accumulations of local alluvium in them are used for gardens and tobacco. These small tracts are very productive of practically all crops, but are worked chiefly by hand and cultivated intensively because of the difficulty of working them with large implements and the scarcity of other acreage suitable for crops in the immediate vicinity. Under average management tobacco yields about 1,400 pounds an acre. On most of this land type pasture is good where the soil material is relatively deep to bedrock. Bluegrass and white clover on most areas produce good grazing in spring, early summer, and late fall, but generally afford scant grazing during the rest of the pasture season due to lack of moisture. Those parts in sinkholes, however, have favorable moisture conditions for pasture throughout most of the grazing season. Pasture plants respond well to phosphorus and lime.

Rough gullied land (limestone residuum).—This land type represents areas of soils over limestone, eroded to the extent that they cannot be economically reclaimed except through very slow processes. A large part of the surface soil and much of the subsoil have been lost and gullies, many of which are not crossable by farm machinery, form an intricate pattern. The surface is rough or broken by erosion channels, and the general slope ranges from sloping to steep.

This land type is widely distributed in those parts underlain by limestone, but the greater part is south of Richland Knobs. Most of it

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represents areas of badly eroded Fullerton, Clarksville, Bolton, Decatur, and Talbott soils. The individual areas range from 1 or 2 acres to about 25.

This land type is poorly suited to crops and pasture. Moisture relations for plants are unfavorable, and the capacity for holding moisture available to plants is very low. Infiltration is slow owing chiefly to the absence of a mellow friable surface soil, consequently runoff develops quickly during rains. Permeability to roots, however, is generally fairly good. The soil material is moderately to strongly acid, and the content of organic matter is very low. The content of plant nutrients ranges from moderate to low according to the nature of the parent soil. Rough gullied land developed from Decatur soils has a moderate content of plant nutrients, whereas that developed from Clarksville has a low content.

All this land type has been cleared and cultivated, but all of it is now abandoned. Some areas are nearly bare, with a scattered growth of sassafras, broomsedge, and briers; others have a good cover of pine.

Erosion, which has brought about the development of this land type, is the result of improper soil management. Vegetation that will arrest further erosion should be established with the expectation of eventually establishing either a profitable forest cover or permanent pasture. Some areas now are suitable for pines and should be planted to them, and certain deciduous hardwoods, as locust, may be suitable for the draws where some soil material has accumulated and where moisture relations are most favorable. The most severely damaged areas may be best started toward rejuvenation by first establishing a cover of brushy growth, as honeysuckle. Kudzu is suited to rough gullied land, and when once established affords grazing. Generally it establishes itself slowly on the less fertile droughty sites, but on the more favorable parts, it develops an effective cover for arresting erosion within a few years. After a period of rejuvenation some areas will be suitable for pasture and certain crops but due to the high clay content of the soil material, favorable moisture relations for good pasture and crops will be difficult to develop. There are a few areas that, if worked to a smooth surface and heavily fertilized, are capable of supporting pasture and certain crops within a short period. A large part of this land type will not be suitable for pasture or crops at any time even following a period of rejuvenation and therefore should be used permanently for forest.

Rough gullied land (shale and sandstone residuum).—This land type represents areas of soils over shale, sandstone, and interbedded shale and limestone, eroded to the extent that they cannot be economically reclaimed except through very slow processes. A large part of the surface soil and much of the subsoil have been lost and gullies, many of which are not crossable by farm machinery, form an intricate pattern. The surface is rough or broken by erosion channels, and the general slope ranges from sloping to steep.

All this type is widely distributed throughout those parts of the county underlain by shale, sandstone, and interbedded shale and limestone. Much of it represents areas of badly eroded Armuchee soils. The individual areas range from 3 or 4 acres to about 40.

This land type is poorly suited to crops and pasture. Moisture

relations for plants are very unfavorable, and the capacity for holding moisture available to plants is low. Infiltration is slow chiefly because of the absence of a mellow friable surface soil, consequently a large part of the water is lost by runoff. Permeability to roots is not good due to the shallow depth to bedrock. The soil material varies from strongly acid to neutral according to the nature of the parent rock. The content of organic matter and plant nutrients is low.

All this land type has been cleared and cultivated but all of it is now abandoned. Some areas are nearly bare, having only a scattered growth of sassafras, broomsedge, and briers; others have a good cover of pine.

Erosion, which has brought about the development of this land type, is the result of improper soil management. Vegetation that will arrest further erosion should be established with the expectation of eventually establishing a profitable forest cover or permanent pasture. Some areas that are now suitable for pines should be planted to them, and certain deciduous forest species, as locust, may be suitable for the draws where soil material has accumulated and where moisture relations are most favorable. The most severely damaged areas may be best started toward rejuvenation by first establishing a cover of brushy growth, as honeysuckle. Kudzu is suited to rough gullied land and when once established, affords grazing. Generally, it establishes itself slowly on the less fertile droughty sites, but on the more favorable parts it develops an effective cover for arresting erosion within a few years.

After a period of rejuvenation, some areas will be suitable for pasture and certain crops but due to the high clay content of the soil material, favorable moisture relations for good pasture and crops will be difficult to develop. A few areas if worked to a smooth surface and heavily fertilized are capable of supporting pasture and certain crops within a short period. A large part of this gullied land type will not be suitable for pasture or crops at any time, even following a period of rejuvenation, and therefore should be used permanently for forest.

Rough stony land (Muskingum soil material).—A land type consisting of numerous sandstone outcrops with an irregular accumulation of fine sandy loam soil material and sandstone fragments and boulders between them (pl. 7, *B*). The surface is predominantly steep (30 to more than 60 percent). All this type is on Clinch Mountain and is underlain by rocks of the Clinch and Clinton geologic formations. Separate areas are large and practically contiguous along the southeast slope of this range. The native vegetation was yellow pine with some deciduous hardwoods, chiefly oak intermixed.

Practically all this land type is occupied by cut-over virgin forest. As it is unsuited to crops and very unproductive of pasture, it should be used permanently for forest.

Rough stony land (Talbott soil material).—A land type consisting of numerous limestone outcrops with an irregular accumulation between them of limestone fragments and soil material, the parent rock of which was limestone. The soil material occupies 25 to 75 percent of the areas and in most places resembles the Talbott and Colbert soils. That part in areas over dolomitic limestone resembles Fullerton and Clarksville soils. This land type differs from Rolling stony land (Talbott soil material) and Hilly stony land (Talbott soil material) chiefly

in having a steeper slope and in general somewhat more limestone outcrops. The most extensive areas are on Richland Knobs. The native vegetation was mixed cedar and deciduous hardwoods.

This land type is not suited to crops and is poor to fair pasture. The abundance of rock outcrop and the shallow depth to bedrock make tillage impractical and productivity low. Pasture plants grow on the soil material but droughty conditions prevail because of the limited available moisture.

Much of this land type is under forest of cedar and deciduous hardwoods. Cleared areas are used for pasture. These afford some grazing but in general the land is best used for forest.

Sandstone outcrop.—This land type consists chiefly of sandstone outcrops and fragments. Small thin accumulations of Muskingum stony fine sandy loam may be in places, but it is of little significance from the standpoint either of pasture or of forest. The surface is predominantly steep to precipitous, although about 25 percent of the acreage has a slope of 12 to 30 percent. Practically all the soil is on the crest and upper part of the southeastern slope of Clinch Mountain. The areas range from 10 to 160 acres and represent the most stony or rocky parts of Rough stony land (Muskingum soil material). Very little vegetation is on this type. Most of it consists of yellow and Virginia pines. This land type has practically no value for crops or pasture, and forest growth is sparse and slow.

Sequatchie fine sandy loam.—Occurring on some of the low stream terraces along the Holston and Clinch Rivers, this type consists of sandy alluvium, the material of which was derived from sandstone and shale with some material from limestone intermixed. The surface is gently undulating to undulating, although there is a small quantity that has a slope of 5 to 12 percent. Internal drainage is good. In general the areas are adjacent to the first bottoms and are seldom more than 10 or 12 feet above these bottom lands. About half of this type was inundated by the Cherokee Reservoir. The areas now in the county are along the Holston River downstream from the Cherokee Reservoir and a few along the Clinch River north of Thorn Hill. The areas range from a few to about 40 acres and are associated with Bruno soils on the adjoining bottoms and Waynesboro and Holston soils on the adjoining higher stream terraces.

A profile description is as follows:

0 to 10 inches, light-brown or light yellowish-brown friable fine sandy loam.

10 to 32 inches, yellowish-brown firm but friable sandy clay loam or sandy clay.

32 inches +, light yellowish-brown moderately mottled with gray and brown friable sandy clay or sandy clay loam. Bedrock lies at a considerable depth.

A few areas are more sandy, the surface soil being loamy fine sand and the subsoil a coarse fine sandy loam. Here the material below a depth of 3 feet is fine sand. Some areas have a lighter colored surface soil and a more yellow subsoil, the color profile resembling that of the Holston soil of the higher stream terraces. In the areas that have been

moderately eroded 50 to 75 percent of the original surface layer has been lost and the plow layer consists of a mixture of surface and subsoil materials.

This soil is medium to strongly acid and is moderately fertile, but the content of organic matter apparently is moderately low. It is permeable to roots and moisture. Its capacity for holding moisture available to plants is only moderate, but moisture from light rains is largely available to plants during dry periods because of relatively small quantities held by the clay particles. The most sandy areas, however, are notably droughty.

The soil is good to very good cropland and fair to good pasture land. Its productivity is good, it responds well to good management, is suited to a wide variety of crops, and is easily worked and conserved. With proper fertilization much of it should be particularly well suited to root crops and certain other truck crops.

Practically all this soil is cleared and used for crops and pasture. About 40 percent is used for corn and tobacco, 30 percent for small grains, and 30 percent for hay and pasture. Most areas are used in a short rotation and some are used for corn several years in succession. Little barnyard manure is applied and green-manure crops are not commonly grown. Some organic matter is added when meadow sod is plowed under. Light applications of mixed fertilizer are made for corn and wheat, and lime has been applied to some areas. Under average management, corn yields about 28 bushels, wheat about 14 bushels, and lespedeza about 1 ton an acre.

Organic matter, lime, and the three plant nutrients, nitrogen, phosphorus, and potassium, are required at regular intervals if a high productivity is to be maintained. Much of the nitrogen requirement can be met by using a rotation in which red clover and alfalfa are a part and in which crimson clover is used as a winter cover crop. All these legumes require a relatively high state of fertility if they are to produce well and effectively aid in maintaining the nitrogen supply. Except on the more sloping parts, a moderately short rotation is well suited providing the fertility is maintained at a high level. The more sloping areas should not have row crops on them frequently and, where feasible, field operations should be on the contour. Under good management, corn yields about 40 bushels, barley about 30 bushels, and alfalfa about 3 tons an acre. Although this soil is not so productive of pasture grasses and legumes as are some other soils, good grazing can be maintained where the fertility is brought to a moderately high level. The most sandy areas, however, are not suited to pasture. Lime and phosphorus are the chief amendments necessary for good pasture.

Sequoia silty clay loam, eroded phase.—Most of this soil is developed over interbedded shale and limestone of the Rutledge geologic formation. Much of it is moderately eroded, 50 to 75 percent of the surface layer having been removed by erosion. The uneroded surface layer is 8 to 10 inches thick. Over much of the acreage the plow layer consists of a mixture of surface and subsoil material, but in places the subsoil is exposed, whereas in other limited tracts very little surface soil has been lost. The surface is predominantly rolling, the gradient ranging from 5 to 12 percent. Internal drainage is fair to slow but

adequate. Most of the soil is in the vicinity of and south of Blaine and east and southwest of Tate Springs. There are also a few areas in Potato Valley to the southeast of Log Mountain. Separate areas are irregular in shape and range from 5 to 30 acres. The native vegetation was chiefly oak, hickory, maple, and other deciduous hardwoods, with some pine intermixed.

A profile description is as follows:

0 to 5 inches, light yellowish-brown to moderate yellowish-brown friable silty clay loam.

5 to 25 inches, light reddish-yellow moderately tough silty clay with some grayish mottlings in the lower part.

25 inches +, splotched or mottled yellowish-red, yellow, and gray moderately tough silty clay. Bedrock shale is at a depth of 25 to 45 inches, the shallower depth being in the eroded and more sloping parts. Soft shale fragments are common throughout.

The thickness of the surface soil varies widely. In the less eroded patches, it may be 7 or 8 inches thick and the few areas still under cut-over virgin forest have a surface soil 8 to 10 inches thick. On the other hand, there are small severely eroded patches where the plow layer consists almost wholly of subsoil material. Some patches have shale fragments in the subsoil, and the most severely eroded patches may have them on the surface.

This soil is strongly acid, low in organic matter, and its content of plant nutrients, especially nitrogen and phosphorus, is only fair. It is slowly permeable to roots and moisture, consequently infiltration is slow and runoff develops rather quickly during rains. Its capacity for holding moisture available to plants is fair but the more eroded patches are notably droughty.

The soil is fair to good for crops and pasture. The rolling surface and the heavy consistence of the more eroded parts make the workability a little difficult and augment the erosion hazard. It is suited to most general farm crops, but because of its rolling surface and the dense nature of the sublayers, it is not particularly well suited to truck crops, especially root crops.

All except a very small part of this soil has been cleared and cropped, and most of it is now used for crops or pasture. About 30 percent is used for corn and tobacco, about 40 percent for hay and pasture, and most of the rest for small grains. Wheat is the predominant small grain crop, and lespedeza is the chief hay crop. A 3- or 4-year rotation consisting of corn, fall-sown small grain, and 1 or 2 years of hay or pasture is common. Some fertilizer is generally used for corn and wheat. The land for tobacco generally receives a good application of barnyard manure supplemented by mixed fertilizer. Lime has been applied at the rate of about 2 tons an acre to some areas. Neither green-manure nor cover crops other than small grains are common. Under average management, corn yields about 20 bushels, wheat about 9 bushels, and lespedeza about 0.7 ton an acre.

Good management requires moderately long rotations (4 to 6 years), the addition of lime and organic matter, and an increase of available plant nutrients, especially phosphorus. When a moderately high pro-

ductivity has been established, much of the nitrogen can be supplied through legumes and barnyard manure, although it may be of advantage even then to add some by commercial fertilizer, especially for certain crops early in spring. Red clover, alfalfa, and white clover are suited to this soil, when the fertility is at a high level and lime has been applied in an adequate quantity. White clover and bluegrass afford good grazing, when the fertility is maintained at a high level, but grazing is generally scant in midsummer and early fall due to the seasonal dry conditions. Particular attention should be given to prevent erosion. The soil should be kept in close-growing crops as much of the time as possible, and where feasible, field operations should be on the contour. Other means of controlling runoff are strip cropping and terracing, which may be justified in places.

Sequoia silty clay loam, eroded undulating phase.—This soil represents areas of the silt loam that have lost 50 to 75 percent of the original surface layer by erosion. The uneroded surface layer is 8 to 12 inches thick. The soil is developed over interbedded shale and limestone of the Rutledge geologic formation. The surface layer is undulating, the gradient seldom exceeding 5 percent. Internal drainage is fair to slow, but adequate for general farm crops. This soil is chiefly in Richland Valley, in the vicinity of and south of Blaine, and in the extreme eastern part of the county east of Tate Springs. There are also a few areas in Potato Valley southeast of Log Mountain. The separate areas are irregular in shape and range from 5 to 30 acres. The native vegetation was chiefly oak, hickory, maple, and other deciduous hardwood, with some pine intermixed.

A profile description is as follows:

0 to 5 inches, light yellowish-brown to yellowish-brown moderately friable silty clay loam.

5 to 25 inches, light reddish-yellow moderately tough silty clay with some grayish mottlings in the lower part.

25 inches +, splotched or mottled yellowish-red, yellow, and gray moderately tough silty clay. Bedrock shale is at a depth of 25 to 50 inches, the shallower depth being on the more eroded and more sloping parts. Soft shale fragments are common throughout this layer.

The thickness of the surface soil varies widely, but in general it is a little more than that of the more sloping phase. In the less eroded areas, it may be 7 or 8 inches thick, and the few areas still under cut-over virgin forest have a surface soil 8 to 10 inches thick. On the other hand, there are a few small severely eroded areas where the plow layer consists chiefly of subsoil material.

This soil is medium to strongly acid and moderately low in organic matter. Its content of plant nutrients, especially nitrogen and phosphorus, is moderate. The surface soil is permeable, but the subsoil is slowly permeable to moisture, consequently infiltration is slow and on the more sloping parts runoff develops rather quickly during rains. The capacity of this soil to hold moisture available to plants is fair to moderate but the most eroded patches are notably droughty.

The soil is good for crops and pasture. Its productivity is good, and it is moderately easy to work. Although the slopes are mild,

erosion is active on much of it under average management because of the slow rate of infiltration. It is suited to practically all crops commonly grown in this region, although several of the more permeable friable soils are better suited to root crops and truck crops requiring soil that works easily to a mellow seedbed.

All except a very small part of this soil has been cleared and cropped, and most of it is now used for crops and pasture. About 40 percent is used for corn, about 10 percent for tobacco, about 20 percent for small grains, and about 30 percent for hay and pasture. Wheat is the principal small-grain crop and lespedeza the principal hay crop. A 3- or 4-year rotation of corn, fall-sown small grains, and 1 or 2 years of hay or pasture is common. Some fertilizer is generally used for corn and wheat. The land for tobacco generally receives a good application of barnyard manure supplemented by mixed fertilizer. Lime has been applied to some areas at the rate of about 2 tons an acre. Other than the small grains and green-manure crops, cover crops are not common. Under average management, corn yields about 25 bushels, wheat about 12 bushels, and lespedeza about 0.8 ton an acre.

Good management requires rotations of moderate length (3 to 5 years), the addition of lime and organic matter, and an increase of available plant nutrients, especially phosphorus. When a moderately high productivity has been established much of the nitrogen can be supplied through legumes and barnyard manure although it may be of advantage to add some through commercial fertilizers, especially for requirements of certain crops in early spring. Red clover, alfalfa, and white clover are suited to this soil, where the fertility is at a high level and lime has been applied in an adequate quantity. White clover and bluegrass afford good grazing if the fertility is maintained at a high level, but the grazing is generally scant in midsummer and early in fall due to the seasonal dry conditions.

Some attention is required to keep erosion in check. This may be done by keeping a live, close-growing crop as much of the time as possible, and field operations should be with the contour on the more sloping parts. Other means of controlling runoff such as strip cropping and terracing may be justified on the more sloping parts.

Sequoia shaly silty clay loam, severely eroded phase.—This phase differs from the eroded phase in being more severely eroded. It is developed over interbedded shale and limestone. The surface layer consists almost wholly of subsoil material. In places part of the subsoil has been lost by erosion. Gullies, though not abundant, are common. Very few are too large to be crossed by farm machinery, but many are too large to be obliterated by ordinary tillage. The surface is rolling, the gradient ranging from 5 to 12 percent. Internal drainage is fair to slow. The separate areas are small, 3 to 15 acres, and are widely distributed in Richland Valley, the vicinity of Blaine, the extreme eastern part of the county east of Tate Springs, and in Potato Valley. The native vegetation was chiefly oak, hickory, maple, and other deciduous hardwoods, with some pine intermixed.

A profile description is as follows:

0 to 20 inches, yellowish-brown moderately tough shaly silty clay with some grayish mottlings in the lower part.

20 inches +, splotched or mottled yellowish-red, yellow, and gray moderately tough silty clay. Bedrock shale is at a depth of 15 to 35 inches, the shallower depth being on the more eroded and more sloping parts. Soft shale fragments are throughout this layer and in many places they are in the surface layer.

The soil is strongly acid and its content of organic matter is low. Its content of plant nutrients is low, especially nitrogen. The entire soil is slowly permeable, and infiltration of moisture is very slow. Runoff therefore develops very quickly during rains. As the capacity to hold moisture available to plants is very small, plants suffer from lack of moisture even during moderately dry periods.

This soil is poorly suited to crops and poorly to fairly suited to pasture. Its unfavorable moisture relations and low fertility cause its productivity to be low, and its tough or heavy consistence makes it difficult to work. Any use that makes it necessary to till this soil makes it very difficult to control runoff and even where it is used for pasture, erosion is active unless the fertility has been increased sufficiently to support a good vegetative cover.

All this soil has been cleared and cropped but about 50 percent of it is now lying idle, has reverted to pine forest, or is used as unimproved pasture. The idle and unimproved pasture areas have a growth of broomsedge and some lespedeza intermixed with a variable quantity of sassafras, persimmon, and briers. The cropped part is used for corn, small grains, and lespedeza and redtop hay. Crops are rotated some, and light applications of fertilizer are used for corn and wheat. Green-manure crops and cover crops, other than the small grains, are not commonly grown. Lime has been applied to a few areas. Under average management lespedeza yields about 0.3 ton an acre.

Where at all feasible this soil should either be fertilized adequately and permanent pasture established or it should be forested with pine. If pasture is to be established, at least phosphorus and lime should be applied and a cover of plants, as lespedeza, redtop, and orchard grass established. Where the fertility is increased sufficiently, bluegrass and white clover can be added. Brushy growth will require consistent cutting in order to keep the pasture clean. Areas that must be used for crops should be used under a long rotation, consisting of close-growing small grains and hay and pasture crops. Heavy applications of phosphorus, nitrogen, and lime must be made and the organic-matter content increased greatly if the soil is to be tilled and at the same time maintained in even a fairly productive state.

Talbott silty clay loam, eroded phase.—This is a heavy, moderately fertile soil with a compact subsoil. It occurs on long, rolling hills in the narrow valley troughs that follow exposures of clayey limestone from which the parent material of the soil is weathered. The soil was formed under a hardwood forest of oak, hickory, and maple. The relief ranges from 5 to 12 percent, and surface drainage is moderate. Internal drainage is well established but rather slow because of the compact, somewhat slowly pervious character of the subsoil. The size and shape of the individual soil areas vary, but small irregular-shaped areas and strips much longer than wide are two of the more typical modes of occurrence. The soil is associated chiefly with other Talbott

soils and with Stony land (Talbott and Colbert soil materials) association in the Clinch and Richland Valleys.

A profile description is as follows:

0 to 8 inches, grayish-brown silty clay loam. The material is moderately friable when moist but becomes somewhat sticky when wet and moderately hard when dry. It is low in organic matter and strongly acid in reaction.

8 to 28 inches, yellowish-red sticky plastic silty clay. This material is compact in place, but when disturbed crumbles into well-defined nutlike aggregates, which are moderately resistant to crushing. In many places the faces of the structure particles are covered with glossy yellowish and reddish coatings. The material is strongly acid in reaction.

28 to 60 inches, yellowish-red silty clay mottled with shades of yellow, gray, red, and brown. In places there may be soft irregular-shaped black accretions. This material has a blocky structure and is generally somewhat less compact than the overlying layer. It is strongly acid in reaction. Clayey limestone bedrock is at an average depth of about 5 feet, but the rock floor under the soil is very irregular and depth to rock may vary from a few inches to as much as 10 feet.

The soil is generally free of chert, but in places small quantities of fine chert may be on the surface and in the soil profile. Roots penetrate the soil fairly well, although the compactness of the subsoil layer may inhibit development of the roots of some plants. The soil absorbs and retains moisture only fairly well, and the compact subsoil may make internal drainage somewhat slow. Baking of the surface and formation of a crust in dry periods slows the absorption of water from subsequent rains to a considerable extent.

The soil, as mapped, includes a few variations. In many places a large part or all of the surface soil described has been removed by accelerated erosion. A few small areas are uneroded and have surface layers 12 or more inches thick. In places the color, especially of the subsoil, may be considerably darker than described, approaching that of the Dewey soils. Areas mapped southeast of Blaine have relatively much more sand in the surface layer than normal.

This soil is medium in productivity and is slightly to moderately difficult to work and conserve. Favorable moisture conditions for plant growth are difficult to maintain because the impaired permeability of the subsoil retards moisture movement, which may ultimately result in extreme wet and dry conditions of the surface soil layer. Restricted water absorption increases surface runoff, especially during heavy rainfall, and this accounts largely for the erodibility of the soil. It is fairly well suited to crops requiring tillage, but management requirements are exacting. Legume and grass hays, corn, and small grains are among the better suited crops. Burley tobacco and vegetable crops are not so well suited to this soil as to some others of the county.

Practically all the soil is cleared and used for purposes for which it is fairly well suited, but management practices have not been designed to meet the soils requirements. Estimates show that about 30 percent is used for corn, 40 percent for hay and rotation pasture, and 20 percent

for small grains and other crops. About 10 percent is idle each year. Fertilization is light and irregular, and green-manure crops are not commonly grown. A part of the soil has been limed. Crops are not commonly rotated, corn being grown at frequent intervals on much of the soil and followed by a hay crop or a few years of idleness. Much of the soil is bare in winter, although fall-sown small grains and sod crops are an effective cover on some areas. Under average management methods, corn yields about 22 bushels, wheat about 10 bushels, lespedeza 0.7 ton, and alfalfa 1.7 tons. Average yields of burley tobacco are about 900 pounds an acre, but the quality is generally somewhat inferior, a darker heavier leaf than that most in demand generally being obtained.

Management requirements are rather exacting because of the difficulty in establishing and maintaining favorable conditions for conservation of soil moisture and material. Moderately long rotations, including a large proportion of leguminous and grass sod crops, are well suited to the soil. A row crop, followed by a small grain seeded to alfalfa to remain 3 to 4 years or longer, can be used effectively. A cropping system including only small grains and grasses and legumes for hay or pasture can be used. Lime in moderate to heavy applications is required by the legumes in the rotation. Additions of organic matter by turning under green-manure crops and applications of barnyard manure likewise help to improve soil tilth as well as furnish nitrogen and, in the case of barnyard manure, potassium. All crops will respond to moderate to heavy applications of phosphorus and probably potassium, with parts of these materials being applied to the row crops and small grains and some to the hays and pastures. Growing legumes will supply much of the nitrogen needed in the rotations, but some response of small grains and corn may be obtained from additional nitrogen in commercial fertilizers. Supplies of most of the minor elements are probably sufficient, although some increases in yield and improvement in quality of alfalfa may be obtained by small applications of boron.

The range of moisture conditions over which tillage can be accomplished is rather narrow. Cultivating the soil when it is either too wet or too dry results in puddling or clodding of the surface layer. Wherever practicable all tillage operations should be on the contour, but terraces do not appear to be suited to this relatively shallow heavy-textured soil. Strip cropping may offer a satisfactory method of farming on the longer slopes, but in many places this practice is not feasible because of the short slopes and irregular conformation of the land surface. The control of grazing in periods of adverse moisture conditions is important to prevent injury to the pasture sod and to soil tilth and water-absorbing properties.

Talbott silty clay loam, eroded undulating phase.—Like the eroded phase, this soil was formed in limestone valley troughs under hardwood forests from residuum from the weathering of clayey limestone. It differs in having milder slopes (less than 5 percent) and in properties associated with slope. The soil is chiefly in small areas associated with other Talbott soils and with the Stony land (Talbott and Colbert soil materials) association in Clinch and Richland Valleys. The soil is unimportant from the standpoint of the agriculture of the county as a whole.

The profile is similar to that of the eroded phase, although the surface layer is somewhat thicker, is higher in organic matter, and possesses better tilth; the other soil layers are somewhat thicker. The 10-inch surface layer is a grayish-brown moderately friable silty clay loam underlain by about 24 inches of plastic yellowish-red silty clay, moderately compact in place. The substratum is also similar except that it is mottled with shades of yellow, red, brown, and gray and is slightly less compact. Limestone bedrock is at an average depth of 5 or 6 feet, but the rock floor is uneven and may be at considerably greater or less depths than shown. Outcrops of bedrock on the surface are not uncommon. Conditions for absorption and retention of moisture are fair, although the compact subsoil affects water movements adversely. Variations in degree of erosion, color of soil layers, and texture of the surface layer are included in areas mapped.

This moderately productive soil is fairly easy to work and conserve, but like the eroded phase its range of use is limited to some extent by moderate difficulty in maintaining good tilth and moisture conditions. The soil is suited to growing tilled crops, and most of the field crops commonly grown will do well, although it is less well suited to tobacco and vegetables than many other soils.

At present most of the soil is used for purposes for which it is at least fairly well suited, but management practices are not completely adjusted to the soil needs in most places. Practically all the soil is cleared. About 40 percent is used for corn, 40 percent for hay and rotation pasture, and most of the rest for small grains. Some fertilizer is used on crops, and part of the soil is limed at fairly regular intervals, but applications of both are determined more by the financial ability of the farm operator to purchase these materials than by soil needs. Much of the soil remains bare of vegetation in winter, and other special practices for runoff and erosion control are not ordinarily used. Under current management methods, corn yields 27 bushels an acre, wheat 11 bushels, lespedeza 0.8 ton, alfalfa 1.8 tons, and tobacco 1,000 pounds.

A 3- to 5-year rotation of corn, small grain, and hay is suited to the soil. Lespedeza and grass or red clover may be used for the forage crop in the shorter rotations and alfalfa or clover in the longer ones. Moderate to heavy applications of lime and phosphorus are required to insure success with legumes and can well be applied just prior to the seeding of these crops. Some additional phosphorus and some potassium will likely be needed by the small grain and row crop. Sufficient nitrogen may be obtained from the legumes in the rotation, but response to small applications of commercial fertilizers may be obtained on grain crops. Tillage on the contour is a good practice, but it may not be feasible in many places because of the irregular shape and small size of the areas. Terracing is generally not a good practice on this soil. Considerable care in choosing correct moisture conditions for tillage is necessary to avoid impairment of soil tilth. Many small areas cannot be feasibly used and managed by themselves and can best be farmed in connection with associated areas of the eroded phase. Under a good system of management, corn yields 38 bushels, wheat 17 bushels, lespedeza 1.3 tons, alfalfa 2.2 tons, and tobacco 1,200 pounds in a moderately favorable season.

Talbott silty clay loam, eroded hilly phase.—Differs from the eroded phase chiefly in having stronger slopes and occurs on slopes (12 to 30 percent) of low hills in and bordering the low-lying limestone valleys, including Clinch and Richland Valleys. The soil was formed from clayey limestone material under hardwood forest. Surface drainage is rapid, but internal drainage may be somewhat restricted by compact subsoil.

The profile is similar to that of the eroded phase, though the soil layers are slightly thinner. The 6-inch surface layer is a grayish-brown silty clay loam, and the subsoil a yellowish-red silty clay. The substratum is mottled. Bedrock is at a depth of 5 feet or less and may outcrop on the surface in places. The surface layer is low in organic matter, and the soil is strongly acid throughout the profile. Because of rapid runoff on the strong slopes and the slowly permeable character of the subsoil, moisture relations are unfavorable. Good tilth is moderately difficult to maintain.

Moderate variations in the color and thickness of soil layers, and in the texture of the surface layer are included in the soil as mapped. A few areas are underlain by limestone interbedded with shale rather than clayey limestone, particularly on the northwest side of Log Mountain.

Poor workability and conservability make this soil poorly suited to growing crops under present conditions, but because of at least moderate productivity it is fairly well suited to growing pastures if properly managed.

All this soil has been cleared but at the present time about 30 percent is abandoned to forest or unimproved pasture or is lying idle. About 10 percent is used for corn, 50 percent for hay and pasture, and 10 percent to other crops, mainly small grains. Little fertilizer is used on the soil, and only small areas are limed. Winter cover crops are not ordinarily raised, and other practices for conserving moisture and soil material are not used. Under prevailing systems of management, yields of about 16 bushels of corn, 8 bushels of wheat, and 0.6 ton of lespedeza hay an acre are obtained.

The soil is exacting in management requirements. It cannot be conserved when used for growing crops that require tillage, but it is fairly well suited to pasture. Pastures require moderate to heavy applications of lime and phosphorus and possibly potassium. Careful control of grazing, scattering of droppings, and clipping to control weeds are other pasture management requirements. Where the need for land makes the use of the soil for cropping purposes necessary, long rotations consisting largely of close-growing hay and pasture crops are best suited. Lime, phosphorus, and potash are needed by crops in such a rotation. If legumes are included in the sod crops, little nitrogen will be needed by grains, although profitable increases in yields may be obtained in places by the use of commercial sources of nitrogen or barnyard manure. Contour tillage is required where feasible, and strip cropping may be a useful practice on the longer slopes. Terraces are generally not suited to the strong slopes. Yields of 25 to 50 percent above those currently obtained can be had under a good system of management.

Talbott silty clay loam, severely eroded hilly phase.—This phase is similar to the eroded hilly phase, differing chiefly in having lost prac-

tically all the surface soil and in places part of the subsoil as a result of erosion. Because of the strong slopes and eroded condition surface runoff is rapid. Organic matter is very low as are most mineral plant nutrients. The soil is strongly to very strongly acid in reaction.

The soil is very difficult to work and conserve and is relatively low in productivity. It is unsuited physically to crops requiring tillage and very poorly suited to pasture. Its best use is for forestry.

All this soil has been cleared, but about half of it is now abandoned to forest or unimproved pasture or is idle land. The rest is in hay or pasture. Very few or no special management practices are used, and yields of crops are generally low and of poor quality. Since the soil is not well suited to either crops or pasture, its requirements for good management are concerned with establishing and maintaining forests. Where the use of the soil for pasture seems necessary, management practices similar to those for the eroded hilly phase are required.

Tyler very fine sandy loam.—This is a poorly drained, light-colored, and strongly acid soil. It is characterized by a light-textured surface layer and a tough compact subsoil. It is in nearly level to slightly depressed positions on old high terraces associated with soils of the Holston series. The soil was formed from parent material derived from old stream alluvium washed principally from uplands underlain by acid shale and sandstone with some admixture of limestone material in places. The original vegetation consisted of hardwood forests. Slopes range from 0 to 5 percent, but most of the soil is on slopes of 0 to 3 percent gradient. The soil is in small areas on terraces along the Holston River. Because of the small acreage and the limited range of use suitability this is not an important soil.

A profile description is as follows:

0 to 16 inches, light-gray friable very fine sandy loam. This material is low in humus, although in many places it may contain considerable quantities of partly decomposed plant residues. It is strongly to very strongly acid in reaction.

16 to 36 inches, grayish-yellow moderately compact very fine sandy clay mottled with yellow, gray, and brown. It is strongly to very strongly acid in reaction.

36 inches +, gray compact silty clay, ranging in thickness from a few feet to many. It is underlain by sedimentary rocks, mostly acid shale, but also by limestone and dolomite in places.

The lower layers are slowly permeable to moisture, and the soil profile remains saturated much of the year, but becomes very hard and dry during prolonged droughts. Likewise aeration is generally poor, varying, however, according to moisture conditions. Roots penetrate the surface layer with ease, although their development may be impeded by unfavorable moisture conditions. The slowly permeable character of the subsoil and substratum inhibits development of roots of most crop plants.

The chief variations in this type as mapped are in the thickness of the soil layers and in drainage conditions. The surface layer is 10 to 16 inches thick and the subsoil is 10 to 20 inches. Several small areas are so poorly drained that they will not produce good pasture grasses.

This soil is difficult to work, easy to conserve, and low in natural pro-

ductivity. Because of poor drainage, strong acidity, inherent poverty in essential plant nutrients, and difficulty in maintaining good tilth, this soil is not physically suited to crops requiring tillage, but it is fairly well suited to growing grasses under good management. Fair success with corn and sorghum can be expected on some of the better drained areas. Lespedeza and redtop are among the pasture plants suited to the soil. Where adequate amendments, including lime and phosphate, are used bluegrass and white clover may do fairly well.

At the present time nearly all this soil is cleared and used for farming. About three-fourths of it is in meadows used for pasture or for hay production. Most of the rest is in corn and sorghum, although some areas are idle each year and a few are in forest. Ordinarily lime and fertilizers are not used on pasture and hay crops and no other special management methods are practiced. Yields are very low—0.3 ton of lespedeza an acre and 20 cow-acre-days of grazing being the average generally obtained under prevailing management. In a few places where the soil is artificially drained, average yields of 25 bushels of corn and 0.7 ton of lespedeza are obtained.

Little response from the use of fertilizers on pastures can be expected where the soil is not drained, but on drained areas good results may be expected from the use of small to moderate quantities of lime, phosphorus, and possibly potash. These materials encourage the growth of the more desirable grasses and legumes, but in many places clipping may be necessary to eradicate weeds. Careful control of grazing during periods of extreme moisture conditions is another pasture management requirement. Under good management about 45 cow-acre-days of grazing an acre can be expected. On the better drained parts, it may be practical to alternate corn and hay.

Waynesboro very fine sandy loam, eroded phase.—This reddish sandy well-drained soil on old stream terraces is closely associated on the terraces with other Waynesboro soils and with those of the Holston and Sequatchie series. Bruno and associated soils are on the nearby bottom lands. This phase was developed under hardwood forest from stream-deposited materials largely of acid sandstone and shale origin with some admixture of material from limestone. Slopes range up to about 5 percent, and both surface and internal drainage are good. The soil occurs on the terraces bordering the Holston River.

A profile description is as follows:

0 to 8 inches, light brownish-gray to grayish-brown friable very fine sandy loam. The material is generally strongly acid in reaction and is low in organic matter.

8 to 32 inches, reddish-yellow to yellowish-red friable sandy clay that is strongly acid in reaction.

32 inches +, red sandy clay mottled with yellow, gray, and brown. This material ranges in thickness from a few inches to as much as 10 feet. It is underlain chiefly by limestone bedrock or residuum derived from limestone.

The surface and subsoil layers are readily permeable to roots and air. Moisture circulates freely, but the soil retains water sufficiently well to insure an adequate supply for plant growth at all times except in periods

of very low rainfall. A few quartz gravel are on the surface and in the soil profile in most places, and they may constitute a fairly large part of the soil mass in places. These places are indicated on the soil map by gravel symbols.

As mapped the soil includes a few moderate variations. A few small areas are less eroded than the type and have thicker surface layers. Several other small areas have darker or browner surface and subsoil layers than those described.

This soil is fairly easy to work and to conserve, and moderate in natural fertility. It is well suited to growing both crops and pasture. Corn, lespedeza, small grains, and burley tobacco will do well on the soil if properly managed. Alfalfa, red clover, and other legumes will yield well if given adequate soil amendments. Because of light texture and good internal drainage, the soil is well suited to early vegetable crops.

At the present time practically all the soil is cleared. Most of it has been used for corn, hay, pasture, and small grains, but a great part is now flooded by the Cherokee Reservoir and is out of agricultural use. Yields of crops vary according to management, but under prevailing systems of management corn yields about 30 bushels, wheat 15 bushels, and lespedeza 1.1 tons an acre.

Management requirements are moderately exacting. Practices for supplying lime, phosphorus, and potassium, and for maintaining or increasing nitrogen and organic matter are needed. Some practices for conserving soil moisture and soil material are required on most areas. Under good management corn yields about 45 bushels, wheat 20 bushels, and lespedeza 1.5 tons.

Waynesboro very fine sandy loam, eroded sloping phase.—Occurring on the more strongly sloping parts of the well-drained river terraces underlain by materials washed from shale and sandstone, this phase differs from the eroded phase chiefly in having stronger slopes (5 to 12 percent) and in properties closely associated with slopes. This soil has lost more material by erosion, and both the surface and subsoil layers are slightly thinner than those of the eroded phase.

The 4- to 6-inch surface layer is brownish-gray friable very fine sandy loam, the subsoil is reddish-yellow sandy clay about 2 feet thick, and the substratum is red sandy clay mottled with yellow, gray, and brown. The soil is generally strongly acid throughout, the surface layer is low in organic matter, and plant roots penetrate all parts of the profile with ease. The moisture supply is generally adequate for plants, although crops may be injured by lack of water during periods of low rainfall. In places some gravel is on the surface and in the soil profile.

This soil is fairly easy to work, but it is moderately difficult to conserve. The supply of organic matter, lime, and mineral plant nutrients is relatively low. Corn, tobacco, small grains, and hay will do well on the soil if carefully managed. Alfalfa and clover will yield satisfactorily if supplied with lime and phosphorus as will grass-legume pasture mixtures.

Practically all this soil is cleared. At the present time a large part is flooded by the Cherokee Reservoir. Previously it was used for corn, hay, small grains, tobacco, pasture, and other crops. Management practices were only fairly well adjusted to the requirements of the soil,

and yields were comparatively low, generally averaging about 25 bushels of corn, 12 bushels of wheat, and 0.9 ton of lespedeza an acre.

A 4- to 6-year rotation including a row crop for 1 year followed by a small grain seeded to a legume or a legume-grass mixture for hay or pasture is well suited to the soil. Phosphorus and potassium fertilizers will give increases in yields of all crops, and lime applications are necessary to insure success with legumes. Contour tillage should be practiced wherever possible, but other special practices for conservation of soil moisture and material are generally not needed where a good cropping system is followed.

Waynesboro very fine sandy loam, eroded hill phase.—This soil is associated with the other Waynesboro soils on the old well-drained sandy river terraces. It has slopes of 12 to 30 percent, but most areas are between 15 and 25 percent. A few areas have lost practically all the original surface layer, and here, the present surface soil consists of the upper part of the original subsoil. On a few forested areas practically all the original 8 to 12 inches of brownish-gray surface soil remain. Most of the phase is on the hilly terrace slopes grading into the adjacent uplands, although some of it is on the short steep slopes between the terraces and the nearby bottom lands.

The profile is similar to those described for the other Waynesboro soils, although the soil layers are generally somewhat thinner because of the stronger slopes and greater erosion. The few inches of the surface layer are brownish-gray friable very fine sandy loam, and the subsoil is reddish-yellow sandy clay. The latter layer is 1½ to 2 feet thick and is underlain by several inches to a few feet of mottled red sandy clay resting on limestone bedrock or limestone residuum. Small quantities of gravel may be on the surface and in the soil profile. The soil is readily permeable to roots, air, and moisture but water supplies for plants are less plentiful than on other Waynesboro soils because of the greater loss in surface runoff.

This phase is moderately difficult to difficult to work and conserve and is rather low in natural fertility. Because of strong slope, eroded condition, and susceptibility to further erosion, it is not suited to growing row crops, but under good management it is fairly well suited to pasture. Grasses and grass-legume mixtures will do well if supplied with adequate amendments.

More than three-fourths of this soil is cleared and used for farming, chiefly hay and pasture crops, although small areas may be used for row crops and small grains in places. Under current management methods corn yields 16 bushels an acre, lespedeza 0.6 ton, and pasture 50 cow-acre-days of grazing.

This soil can best be conserved if used for pasture and hay crops. Increased yields and improved quality of all pasture crops may be obtained by the use of lime and phosphorus, and these materials are essential to insure success with alfalfa and red clover. Other practices required for good management of pastures are control of grazing, eradication of weeds, and scattering of droppings.

PRODUCTIVITY RATINGS

In table 8 the soils are listed alphabetically and estimated average acre yields of the principal crops are given for each.

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TABLE 8.—*Estimated average acre yields of the principal crops, and the workability, con land classification of the soils in Grainger County, Tenn.*

[In columns A the estimated yields are those to be expected under soil management commonly pra
In columns B the estimated yields are those to be expected under good practices of manage

Soil (type, phase, or land type)	Corn		Wheat		Oats		Barley		Lespedeza		Alfalfa		Tobacco		Potatoes	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Lb.*	*Lb.*	*Bu.*	*Bu*
Abernathy silt loam	50	60	18	28	35	50	25	35	1.7	2.0	3.5	4.0	1,500	1,900	140	22
Armuchee shaly silty clay loam:																
Severely eroded phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Severely eroded steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Armuchee silt loam	(6)	25	(6)	18	(6)	30	(6)	20	(6)	1.3	(6)	2.5	(5)	(5)	(5)	(6
Steep phase	(5)	(5)	(5)		(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Very steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Armuchee silty clay loam:																
Eroded phase	15	22	8	12	18	25	12	18	.7	1.0	1.5	2.0	(5)	(5)	(5)	(5
Eroded steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Atkins fine sandy loam	(5)	(7)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(7)	(5)	(5)	(5)	(5)	(5)	(5
Bolton loam	(6)	32	(6)	18	(6)	35	(6)	26	(6)	1.2	(6)	2.7	(5)	(5)	(5)	(5
Eroded phase	20	30	9	15	22	35	12	22	.8	1.1	2.0	2.5	(5)	(5)	(5)	(5
Eroded rolling phase	28	40	11	16	28	38	16	30	1.0	1.4	2.4	3.0	1,000	1,300	120	17
Eroded steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Bolton silty clay loam:																
Severely eroded phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Severely eroded steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Bruno fine sandy loam	32	45	15	22	34	47	18	28	1.1	1.6	2.3	3.1	(5)	(5)	100	18
Bruno loamy fine sand	15	25	5	10	15	25	(5)	(5)	.3	.7	1.2	1.8	(5)	(5)	45	7
Clarksville cherty clay loam, severely eroded hilly phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Clarksville cherty fine sandy loam:																
Eroded phase	13	25	6	13	10	20	(5)	(5)	.3	.8	(5)	1.0	(5)	(5)	(5)	(5
Eroded hilly phase	9	15	5	8	9	15	(5)	(5)	.3	.7	(5)	(5)	(5)	(5)	(5)	(6
Hilly phase	(5)	15	(5)	10	(5)	18	(5)	(5)	(5)	.8	(5)	.9	(5)	(5)	(5)	(5
Clarksville cherty silt loam	15	25	8	14	13	28	(5)	(5)	.5	1.1	(5)	1.5	700	900	50	12
Eroded hilly phase	10	18	6	11	10	20	(5)	(5)	.3	.9	(5)	1.0	(5)	(5)	(5)	(5
Eroded steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Hilly phase	(6)	20	(6)	12	(6)	24	(5)	(5)	.4	1.0	(5)	1.2	(5)	(5)	(5)	(5
Steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Clarksville fine sandy loam:																
Eroded phase	15	25	8	14	13	28	(5)	(5)	.5	.9	(5)	1.4	700	900	50	12
Eroded hilly phase	10	18	6	11	10	20	(5)	(5)	.3	.8	(5)	1.0	(5)	(5)	(5)	(5
Colbert silt loam	18	30	10	16	20	30	15	25	.8	1.2	1.8	2.3	700	1,000	70	11
Colbert silty clay loam, eroded rolling phase	14	23	7	11	18	28	10	15	.6	1.0	1.6	2.2	(5)	(5)	(5)	(5

Cumberland silt loam	35	50	18	25	35	60	22	35	1.5	1.7	3.2	3.8	1,200	1,600	120	20
Cumberland silty clay loam, eroded sloping phase	32	45	16	20	32	50	20	32	1.1	1.5	2 5	3.2	1,100	1,500	110	19
Decatur silty clay loam:																
Eroded phase	33	45	15	23	33	52	20	32	1.1	1.5	2.7	3 3	1,200	1,600	115	18
Eroded hilly phase	25	35	12	18	28	40	16	28	1 0	1.4	2.4	3 0	(5)	(5)	(5)	(5
Eroded undulating phase	35	50	18	25	35	60	23	36	1.3	1.7	3.2	3.8	1,300	1,700	120	20
Severely eroded phase	10	25	5	10	11	28	(5)	15	.3	.7	(5)	1.6	(5)	(5)	(5)	(5
Severely eroded hilly phase	8	20	4	8	10	22	(5)	12	.2	.6	(5)	1.3	(5)	(5)	(5)	(5
Dewey silty clay loam:																
Eroded phase	30	45	15	20	30	50	20	32	1.1	1 5	2 5	3.1	1,100	1,500	110	17
Eroded undulating phase	33	48	16	23	33	55	22	35	1.2	1.6	3 0	3 5	1,200	1,600	115	19
Emory silt loam	40	50	18	25	35	60	22	35	1.3	1.7	2 8	3.5	1,300	1,700	120	20
Sloping phase	33	45	15	23	33	52	20	32	1.2	1.6	2.7	3 2	1,200	1,600	115	18
Etowah silt loam	35	45	16	23	33	55	22	35	1.2	1.6	3.0	3.5	1,200	1,600	115	19
Fullerton cherty clay loam:																
Severely eroded phase	(5)	----	(5)	----	(5)	22	(5)	(5)	3	.6	(5)	(5)	(5)	(5)	(5)	(5
Severely eroded hilly phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	.3	5	(5)	(5)	(5)	(5)	(5)	(5
Fullerton cherty fine sandy loam	15	25	8	15	16	32	(5)	(5)	.5	.8	(5)	1 4	700	900	50	12
Eroded phase	12	22	7	15	14	32	(5)	(5)	.4	.7	(5)	1 3	700	900	50	12
Eroded hilly phase	(5)	(5)	6	12	10	24	(5)	(5)	4	.9	(5)	1.2	(5)	(5)	(5)	(5
Hilly phase	(5)	(5)	6	12	10	25	(5)	(5)	4	.9	(5)	1 2	(5)	(5)	(5)	(5
Fullerton cherty silt loam	22	33	10	18	22	35	14	28	.6	1 2	1.6	2 1	800	1,100	65	14
Eroded phase	20	30	8	17	21	33	12	26	.5	1.1	1 5	2 0	800	1,100	60	13
Eroded hilly phase	15	28	7	13	15	26	10	22	4	1.1	(5)	(5)	(5)	(5)	(5)	(5
Eroded steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Hilly phase	(5)	28	7	13	15	28	10	22	4	1 1	(5)	(5)	(5)	(5)	(5)	(5
Steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Fullerton cherty silty clay loam:																
Severely eroded hilly phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	3	.9	(5)	(5)	(5)	(5)	(5)	(5
Severely eroded steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Fullerton fine sandy loam	23	33	10	18	22	38	12	26	7	1.3	1.8	2.3	900	1,200	75	15
Eroded phase	22	33	10	18	22	36	12	24	.6	1.2	1 6	2 1	800	1,100	75	15
Eroded hilly phase	15	28	8	13	18	30	10	20	4	.9	1.4	1.8	(5)	(5)	(5)	(5
Hilly phase	(6)	28	(6)	13	(6)	30	(6)	22	(6)	1.1	(6)	1.9	(6)	1,100	(6)	15
Severely eroded hilly phase	10	20	4	10	8	20	(5)	(5)	.4	1 0	(5)	(5)	(5)	(5)	(5)	(5
Undulating phase	25	38	11	19	25	40	15	28	.7	1.3	2 0	2.5	1,000	1,300	70	16
Fullerton silt loam:																
Eroded phase	25	38	11	21	25	40	15	30	.7	1.3	2.0	2.6	1,000	1,300	70	15
Eroded hilly phase	20	30	10	14	20	30	12	24	.5	1.1	1.5	2.0	(5)	(5)	(5)	(5
Hilly phase	(6)	32	(6)	16	(6)	32	(6)	26	(6)	1.2	(5)	2.4	(5)	(5)	(5)	(5
Greendale loam	28	40	12	22	28	42	16	32	.8	1.3	2.1	2.8	1,000	1,300	75	16
Sloping phase	22	35	10	18	22	38	12	28	.7	1.2	1.8	2.1	900	1,100	90	16
Greendale silty clay loam	28	40	14	22	30	42	16	32	1 0	1.6	2.1	2.8	1,000	1,300	75	16
Sloping phase	22	35	10	18	22	38	12	28	.8	1.4	1 8	2.1	900	1,100	75	13
Guthrie silt loam	(5)	[7]30	(5)	(5)	(5)	(5)	(5)	(5)	.4	7.7	(5)	(5)	(5)	(5)	(5)	(5
Hayter loam	40	50	20	28	35	60	25	38	1.5	2.0	3.2	4 0	1,400	1,800	145	25
Eroded sloping phase	36	48	18	25	28	50	25	36	1 0	1.8	3.6	4 7	1,300	1,700	135	20
Hayter stony loam:																
Eroded phase	35	45	18	25	28	45	25	36	1.0	1.8	3 6	4.7	1,300	1,700	135	19
Eroded hill phase	25	[8]35	14	[8]20	24	[8]33	22	[8]30	.8	1.5	1.5	2.5	1,000	1,400	120	15
Eroded steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5
Hill phase	(5)	[8]40	(5)	[8]22	(5)	[8]36	(5)	[8]32	(5)	[8]1.7	(5)	[8]2.7	(5)	(5)	(5)	(5

TABLE 8.—*Estimated average acre yields of the principal crops, and the workability, cons land classification of the soils in Grainger County, Tenn.*—Continued

[In columns A the estimated yields are those to be expected under soil management commonly practi
In columns B the estimated yields are those to be expected under good practices of managem

Soil (type, phase, or land type)	Corn		Wheat		Oats		Barley		Lespedeza		Alfalfa		Tobacco		Potatoes	
	A	B	A	B	A	B	A	B	A	B	A'	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Lb.*	*Lb.*	*Bu.*	*Bu*
Severely eroded steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Steep phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Hector stony fine sandy loam	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Hilly stony land:																
Colbert soil material	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Talbott soil material	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Holston very fine sandy loam	23	33	10	15	22	38	12	22	.7	1.3	1.8	2.3	900	1,200	75	155
Eroded sloping phase	20	30	9	13	20	33	10	18	.5	1.1	1.3	1.9	700	1,000	70	145
Huntington silt loam	40	60	16	25	45	65	25	35	1.7	2.0	3.0	3.6	(5)	(5)	(5)	(5)
Jefferson stony fine sandy loam:																
Eroded phase	14	25	6	10	16	27	9	16	.5	.8	(6)	(6)	600	900	50	130
Eroded sloping phase	10	20	5	8	12	20	7	12	.4	.7	(6)	(6)	500	800	70	130
Sloping phase	12	20	5	8	14	22	8	14	.4	.7	(6)	(6)	(6)	900	80	140
Leadvale silt loam	25	35	12	16	27	40	15	20	.7	1.2	(5)	(5)	900	1,200	60	140
Sloping phase	20	30	9	12	22	33	12	18	.6	1.1	(5)	(5)	800	1,000	50	120
Lehew stony very fine sandy loam	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Eroded hilly phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Limestone outcrop	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Lindside silt loam	35	760	10	715	20	750	12	720	1.3	1.6	(5)	(5)	(5)	(6)	(5)	(5)
Melvin silt loam	(5)	735	(5)	(5)	(5)	(5)	(5)	(5)	.6	1.2	(5)	(5)	(5)	(5)	(5)	(5)
Montevallo shaly silt loam:																
Eroded hilly phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	.3	.8	(5)	(5)	(5)	(5)	(5)	(5)
Eroded rolling phase	10	18	5	8	12	25	(5)	(5)	.3	.9	1.2	1.5	(5)	(5)	45	70
Eroded undulating phase	12	25	6	10	15	30	(5)	(5)	.4	1.0	1.5	1.8	(5)	(5)	50	100
Montevallo shaly silty clay loam:																
Severely eroded phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Severely eroded rolling phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Muskingum stony fine sandy loam	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Hilly phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Muskingum very fine sandy loam	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Eroded phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Eroded hilly phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	.3	.9	(5)	(5)	(5)	(5)	(5)	(5)
Hilly phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	.4	1.0	(5)	(5)	(5)	(5)	(5)	(5)
Ooltewah silt loam	35	750	10	715	20	750	12	720	1.3	1.6	(5)	(5)	(5)	(5)	(5)	(5)
Philo fine sandy loam	20	730	8	712	20	735	(5)	(5)	.6	1.0	(5)	(5)	(5)	(5)	(5)	(5)
Pope fine sandy loam	25	40	10	13	25	40	12	18	.9	1.2	(5)	(5)	(5)	(5)	100	180
Roane silt loam	30	45	12	18	30	45	16	25	1.0	1.5	2.2	3.0	1,000	1,300	100	180
Rolling stony land (Talbott soil material)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)

Rough gullied land:																
Limestone residuum	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Shale and sandstone residuum	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Rough stony land:																
Muskingum soil material	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Talbott soil material	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Sandstone outcrop	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Sequatchie fine sandy loam	28	40	14	20	25	42	18	30	1.0	1.5	2.2	3.0	1,100	1,400	100	18
Sequoia shaly silty clay loam, severely eroded phase	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Sequoia silty clay loam:																
Eroded phase	20	30	9	12	20	38	12	20	.7	1.0	1.6	2 0	800	1,000	60	10
Eroded undulating phase	25	38	12	18	25	45	16	28	.8	1.4	2 1	2 7	1,000	1,300	80	15
Talbott silty clay loam:																
Eroded phase	22	32	10	15	22	40	14	22	.7	1.1	1.7	2.1	900	1,100	65	11
Eroded hilly phase	16	30	8	13	18	34	13	20	6	1 1	1 6	2.0	600	850	65	9
Eroded undulating phase	27	38	11	17	28	45	18	28	.8	1 3	1.8	2 2	1,000	1,200	75	12
Severely eroded hilly phase	10	24	(5)	7	10	22	(5)	13	.2	5	(5)	(5)	(5)	(5)	(5)	(5)
Tyler very fine sandy loam	(5)	725	(5)	(5)	(5)	(5)	(5)	(5)	.3	7.7	(5)	(5)	(5)	(5)	(5)	(5)
Waynesboro very fine sandy loam:																
Eroded phase	30	45	15	20	33	48	20	33	1.1	1 5	2 8	3 4	1,100	1,500	110	19
Eroded hill phase	16	32	8	16	18	34	13	20	.6	1 1	1 6	2 0	(5)	(5)	60	9
Eroded sloping phase	25	40	12	18	28	42	16	25	.9	1.2	2.2	2.9	900	1,200	90	15

[1] Workability refers to ease of tillage, harvesting, and other field operations. Relative descriptive terms used are in decreasing order of ease of

[2] Conservability refers to the ease with which the productivity and workability of the soil can be maintained and/or improved. Relative descri
vation.

[3] A classification of the soils according to their relative physical suitability for the agriculture of the county.

[4] Cow-acre-days is a term used to express the carrying capacity of pasture land. As used here it is the product of the number of animal units car
are grazed without injury to the pasture. For example, the soil type able to support 1 animal unit per acre for 360 days of the year rates 360, wher
180 days of the year rates 90. Again, if 4 acres of pasture support 1 animal unit for 100 days, the rating is 25.

[5] Crop is commonly not grown, and the soil is poorly suited to its production.

[6] Crop is commonly not grown, but the soil is at least fairly well suited to its production.

[7] Yields are with adequate artificial drainage, which may not be feasible in all places.

[8] The more stony areas are not suited to this crop.

Two yields are given for most crops on each soil, corresponding to expected yields under two levels of management (columns A and B). Yields expected vary widely on most soils according to the way the soil and crop are managed. Management itself differs greatly from farm to farm.

In columns A, the yields given are estimates based on the present soil-management practices that are stated briefly in each soil discussion in the section, "Descriptions of Soil Units." The practices on any one of the soils are as varied as the farms on which the soil exists, and the degree of that variation is not the same for all soils. Strict definition of the current management of any soil or group of soils resolves into definition of management of that soil for a great many individual farms, or for fields within those farms. It is usually possible, however, to give a general description of one or two major types of management that are commonly practiced on a soil or group of soils. That type of management is chosen to represent the approximate modal level of management of the various soils of the county. A similar level of management is obtained on many farms by different combinations of management practices.

In general, the choice of crops is commonly influenced to a considerable extent by the physical suitability of the soil, but in most places the choice and rotation of crops is not in complete adjustment with the physical suitability of the soils. Rates of application and kinds of fertilizers and other amendments used are usually determined by the crop to which they are applied with less consideration of the needs of the soil on which the crop is grown. Crops on soils of the first bottoms are notable exceptions. Tillage practices are influenced to some extent by the nature of the soil, but they are influenced principally as that nature affects the ease with which tillage is accomplished rather than through consideration of the physical condition of the plow layer or the control of water on the land. Engineering methods of water control are not generally practiced.

Tomatoes, potatoes, string beans, and other vegetable crops generally receive light applications of complete commercial fertilizer. These applications are supplemented or replaced on some farms by the use of manure. Farmers commonly make light applications of superphosphate or of low analysis complete fertilizer in the rotation for corn and small grains. Lespedeza, soybeans, and pasture are not usually fertilized or limed. If alfalfa is grown, it generally receives moderately heavy applications of lime and phosphate at seeding, and management for this crop is at a higher level than for most other crops grown. Tobacco is also generally heavily fertilized.

The more productive soils of the first bottoms are not commonly fertilized for the general crops. Vegetables and other special crops are usually fertilized even on these soils. Corn and other general crops are often fertilized on the Roane, Pope, and Philo soils.

Crops are rotated to some extent, but rotations are not generally planned with special regard to maintenance of productivity and good tilth. Corn or other intertilled crops are commonly grown year after year on the better soils of the first bottoms. An occasional hay crop or small-grain crop may be introduced at relatively long intervals. Corn or other intertilled crops are grown 1 to 3 years in succession on the

soils of the uplands, terraces, and colluvial lands and followed by small grain and hay, as lespedeza or soybeans, for 1 or 2 years. On the hilly and steep phases of Fullerton and Clarksville soils long periods of idleness or unimproved low-quality pasture are common between periods of cropping. Tillage is generally on the contour on hilly and steep phases but is not on the contour on less steep soils. Terracing, strip cropping, and similar practices are not in general use.

The prevailing type of pasture management involves reseeding of soils that have been used for crops requiring tillage. These areas are commonly reseeded to pasture plants, as lespedeza, redtop, orchard grass, ryegrass, and possibly bluegrass, and do not receive amendments after reseeding. Pasture on these areas commonly benefits to a small extent from previous applications of lime and phosphorus for the crops that preceded the pasture. Generally applications of such amendments have been light. The reseeding provides pasture plants that are more desirable than those commonly existing on unimproved permanent pastures. The plants that are reseeded are generally tolerant of low nutrient levels, and although their production would be greatly increased by a good pasture management, the carrying capacity is commonly above that of unimproved permanent pasture. The yields in columns A are estimates of the carrying capacity of such pastures, except in the case of soils on which crops requiring tillage are not commonly grown.

The yield data of columns A are based largely on observations, interviews, and local experience of farmers and agricultural workers. Crop yield data by soil types over a long period of years are used whenever available. The summation of local experience will give fairly reliable yield expectations under the management commonly practiced. In some instances where such information was not available, the yields given in this column are inductive estimates rather than established yields.

In columns B, the yields given are those that represent the expected yields of crops under good management. The term "good management" refers to the proper choice and rotation of crops; the correct use of lime, commercial fertilizers, and manure; proper tillage methods; the return of organic matter to the soil; and engineering methods of water control, where necessary, carried on toward the end of maintaining or increasing soil productivity within feasible limits.

Although present knowledge of the requirements for good management of specific soils for specific crops is limited, some of the deficiencies are known with a reasonable degree of certainty and others are considered to be probable. From this knowledge, some of the requirements of soils for good management are discussed in the section on Land Use and Soil Management.

It must be remembered that just as the management requirements of different crops on the same soil may be different, so also the management requirement of the same crop on different soils may be different. Moreover, the point at which it is no longer profitable for a farmer to intensify further the practices that make for good management depends not only on the soil and the crop but also on the other soils and other crops of the farm, the combination of enterprises of the farm, prices, and numerous other considerations. Therefore the feasible limits of good management are not defined rigidly in this report, both because of lack of

knowledge and because of lack of constancy of those limits.

In addition to the inability to define good management for each soil and crop exactly, data of crop yields obtained under conditions that approach good management are scarce. The estimates in columns B, therefore, are based largely on the best judgment of men who have had experience with the soils and the crops. Their estimates are based on the responses crops would be expected to make over and above yields commonly obtained (as given in columns A).

The yields listed in columns B are intended as production goals that can be reached generally by use of feasible good practices of soil and crop management. The best feasible management for a farm unit may give yields in excess of the goal for one crop and yields below the goal for another crop on the same soil. The yields in columns B should be used in comparison with those in columns A to give an idea of the response that can be expected of crops under a good level of management.

In table 9 the expected yields of various crops on the soils of the county have been converted into indexes, and the soils have been grouped according to their physical suitability for agriculture under prevailing conditions.

The rating compares the productivity of each of the soils for each crop to a standard of 100. This standard index represents the productivity without the use of fertilizers and other amendments on the more extensive and better soils of that region in the United States where the crop is most extensively grown. An index of 50 indicates that the soil is about half as productive as is the soil with the standard index. Some soils that are well managed, or unusually productive, may have productivity indexes of more than 100 for some crops.

The indexes of the productivity rating table are the expected yields of table 8 expressed as percentages of the standard yields adopted for the nation as a whole. The standard yields on which the indexes are based are given in the table under the names of the crops for which the ratings are given. Columns A and B under each crop refer to two levels of management and correspond to similar columns in the table of estimated yields for which the levels of management are defined. The soils are listed in table 9 in the approximate order of their general physical suitability for the important crops of the present agriculture under prevailing management practices. This has been done chiefly on the basis of information acquired through field observation and consultations with farmers and with competent agricultural workers in the State.

The table gives a characterization of the productivity and relative desirability of the individual soil units, but it does not present the relative roles that the different soils play in the agriculture of the county. It cannot determine the total production of crops by soil areas without consideration of the acreage of individual soils used for each of the specified crops. The indexes cannot be interpreted directly into land values. Distance to market, relative prices of farm products, association with other soils of different capability, and other factors influence the value of soils at specific places. The indexes can be used for purposes of comparison of productivity for specific crops (1) on different soils under similar levels of management within the county, (2) on the same soil under different levels of management within the county, and

(3) on the soils of the county with those of other parts of the United States. The indexes can be used to show crop responses that can be expected from different levels of management on the various soils of the county. They can also be used with other information in estimating the total production of crops by soil areas and total production capacity of soil areas, and they can be used as a part of the information necessary in arriving at land values.

PHYSICAL LAND CLASSIFICATION

The units of mapping in the soil survey of Grainger County are classified on the basis of physical characteristics that can be observed in the field. Soils widely separated in the natural classification may be relatively similar for a particular practical objective. Solution of many problems of agriculture involves knowledge of the physical suitability of soils for agricultural uses, and it is necessary to interpret the characteristics of units of mapping in terms of physical suitability for agriculture if the data of the soil survey are to be useful in the solution of such problems. Such interpretation can be made by persons who use the soil survey data for practical objectives, but it is frequently convenient to have interpretive data available in the soil survey report.

The physical suitability of a soil for agricultural use is determined by its characteristics. Many soil characteristics contribute to its productivity[7], workability[8], and conservability.[9] These three conditions determine its physical suitability. A good soil for agriculture is one that is very productive of a large number of important crops, is easily worked, and can be conserved with minimum effort. All the soils of Grainger County fall short of the ideal, but they differ widely in the degree of such departure. Moreover, the degree of departure of any one of the three conditions from the ideal may differ greatly from those of the other two. For example, a soil may be highly productive and easy to conserve, but it may be difficult to till. The relations of productivity, workability, and conservability are very complex in their influences on physical suitability. There is, however, no simple method of evaluating these three conditions and applying the values toward determination of the physical suitability of the soil for agriculture.

Productivity in terms of yields for each soil and workability and conservability are referred to in table 8 by descriptive expressions, as excellent, very good, good, fair, poor, and very poor. The physical land classification of the soil, indicated in the last column of the table, is an estimate of the combined effects of these three factors on the physical suitability of the soil for agriculture.

Soils of excellent workability are generally light- or medium-textured stone-free nearly level soils that require a minimum of effort for tillage and harvesting operations. It is successively more difficult to perform normal farming operations on those of very good, good, and fair workability, but such operations can generally be performed feasibly for crops that require tillage, even on the soils of fair workability. Silty

[7] Productivity refers to the capacity of a soil to produce crops under prevailing or other defined soil management practices.
[8] Workability refers to ease of tillage, harvesting, and other field operations.
[9] Conservability refers to the maintenance or improvement of productivity and workability through saving the soil material and the supply of plant nutrients in the soil.

TABLE 9.—*Productivity ratings of soils and physical classification of land in Grain*

[Indexes in columns A refer to yields obtained under the most common management practices
Indexes in columns B refer to yields expected under the best practices of management.]

Soil (type, phase, or land type)[1]	Crop productivity index[2] for —									
	Corn (100= 50 bu.)		Wheat (100= 25 bu.)		Oats (100= 50 bu.)		Barley (100= 40 bu.)		Lespedeza (100= 1.5 tons)	
	A	B	A	B	A	B	A	B	A	B
FIRST-CLASS SOILS										
GOOD TO EXCELLENT CROPLAND, VERY GOOD TO EXCELLENT PASTURE LAND										
Hayter loam	80	100	80	115	70	120	65	95	100	135
Cumberland silt loam	70	100	70	100	70	120	55	90	100	115
Etowah silt loam	70	90	65	90	65	110	55	90	80	105
Abernathy silt loam	100	120	70	115	70	100	65	90	115	135
Emory silt loam	80	100	70	100	70	120	55	90	85	115
Huntington silt loam	80	120	65	100	90	130	65	90	115	135
Decatur silty clay loam, eroded undulating phase	70	100	70	100	70	120	60	90	85	115
Dewey silty clay loam, eroded undulating phase	65	95	65	90	65	110	55	90	80	105
Emory silt loam, sloping phase	65	90	60	90	65	105	50	80	80	105
SECOND-CLASS SOILS										
FAIR TO GOOD CROPLAND, GOOD TO VERY GOOD PASTURE LAND										
Hayter loam, eroded sloping phase	70	95	70	100	55	100	65	90	65	120
Decatur silty clay loam, eroded phase	65	90	60	90	65	105	50	80	75	100
Cumberland silty clay loam, eroded sloping phase	65	90	65	80	65	100	50	80	75	100
Dewey silty clay loam, eroded phase	60	90	60	80	60	100	50	80	75	100
Sequatchie fine sandy loam	55	80	55	80	50	85	45	75	70	100
Bruno fine sandy loam	65	90	60	90	70	95	45	70	75	105
Greendale loam	55	80	50	90	55	85	40	80	55	90
Bolton loam, eroded rolling phase	55	80	45	65	55	75	40	75	70	95
Lindside silt loam	70	[5]120	40	[5]60	40	[5]100	30	[5]50	85	110
Ooltewah silt loam	70	[5]100	40	[5]60	40	[5]100	30	[5]50	90	[5]110
Waynesboro very fine sandy loam, eroded phase	60	90	60	80	65	95	50	85	75	100
Leadvale silt loam	50	70	50	65	55	80	40	50	50	80
Pope fine sandy loam	50	80	40	50	50	80	30	45	60	75
Fullerton fine sandy loam, undulating phase	50	75	45	80	50	80	40	70	50	90
Roane silt loam	60	90	50	70	60	90	40	65	70	100
Greendale silty clay loam	55	80	55	90	60	85	40	80	70	110
Talbott silty clay loam, eroded undulating phase	55	75	45	70	55	90	45	70	55	90
Fullerton fine sandy loam	55	65	40	70	45	75	30	65	50	90
Eroded phase	45	65	40	75	45	70	30	60	40	80
Holston very fine sandy loam	55	65	40	60	45	75	30	55	50	90
Waynesboro very fine sandy loam, eroded sloping phase	50	80	50	70	55	85	40	65	60	80
Sequoia silty clay loam, eroded undulating phase	50	75	50	75	50	90	40	70	55	95

Fullerton silt loam, eroded phase	50	75	45	80	50	80	40	75	50	90
Greendale loam, sloping phase	45	70	40	70	45	75	30	70	50	80
Jefferson stony fine sandy loam, eroded phase	30	50	25	40	30	55	25	40	35	55

THIRD-CLASS SOILS

Poor to Fair Cropland, Fair to Good Pasture Land

Hayter stony loam, eroded phase	70	90	70	100	55	90	65	90	70	115
Greendale silty clay loam, sloping phase	45	70	40	70	45	75	30	70	55	95
Colbert silt loam	35	60	40	65	40	60	40	65	55	80
Talbott silty clay loam, eroded phase	45	65	40	60	45	80	35	55	50	75
Decatur silty clay loam:										
Severely eroded phase	20	50	20	40	20	55	(4)	40	20	50
Eroded hilly phase	50	70	50	70	55	80	40	70	70	95
Bolton loam	(6)	65	(6)	70	(6)	70	(6)	65	(6)	80
Eroded phase	40	60	35	60	45	70	30	55	55	75
Fullerton cherty silt loam	45	65	40	70	45	70	35	70	40	80
Eroded phase	40	60	30	70	40	65	30	65	35	75
Fullerton cherty fine sandy loam	30	50	35	60	30	65	(4)	(4)	35	55
Eroded phase	25	45	30	60	30	65	(4)	(4)	30	50
Sequoia silty clay loam, eroded phase	40	60	35	50	40	75	30	50	50	70
Philo fine sandy loam	40	[5]60	30	[5]50	40	[5]70	(4)	(4)	40	[5]70
Leadvale silt loam, sloping phase	40	60	35	50	45	65	30	45	40	75
Bruno loamy fine sand	30	50	20	40	30	50	(4)	(4)	25	50
Clarksville fine sandy loam, eroded phase	30	50	30	55	25	55	(4)	(4)	35	60
Clarksville cherty silt loam	30	50	30	55	45	55	(4)	(4)	35	75
Clarksville cherty fine sandy loam, eroded phase	30	50	30	55	25	55	(4)	(4)	35	60
Holston very fine sandy loam, eroded sloping phase	40	60	35	50	40	65	25	45	35	75
Jefferson stony fine sandy loam, sloping phase	25	40	20	35	30	45	20	35	30	50
Eroded sloping phase	20	40	20	30	25	40	20	30	30	50
Fullerton silt loam, hilly phase	(6)	65	(6)	65	(6)	65	(6)	65	(6)	80
Eroded hilly phase	40	60	40	55	40	60	30	60	35	75
Fullerton fine sandy loam, hilly phase	(6)	55	(6)	50	(6)	60	(6)	55	(6)	75
Eroded hilly phase	30	55	30	50	35	60	25	50	30	60

FOURTH-CLASS SOILS

Very Poor to Poor Cropland, Fair to Very Good Pasture Land

Hayter stony loam:										
Hill phase	(6)	80	(6)	80	(6)	70	(6)	80	(6)	115
Eroded hill phase	50	70	55	80	50	65	55	75	55	105
Armuchee silt loam	(4)	50	(4)	70	(4)	60	(4)	50	(4)	90
Rolling stony land (Talbott soil material)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Armuchee silty clay loam, eroded phase	30	45	30	50	35	50	30	45	50	70
Montevallo shaly silt loam, eroded undulating phase	25	50	25	40	30	60	(4)	(4)	30	70
Melvin silt loam	(4)	[5]70	(4)	(4)	(4)	(4)	(4)	(4)	40	[5]80
Hilly stony land:										
Talbott soil material	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Colbert soil material	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Hayter stony loam:										
Steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Eroded steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Armuchee silt loam, steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)

TABLE 9.—*Productivity ratings of soils and physical classification of land in Grainger Co*

FOURTH-CLASS SOILS—Continued
VERY POOR TO POOR CROPLAND, FAIR TO VERY GOOD PASTURE LAND

[Indexes in columns A refer to yields obtained under the most common management practice
Indexes in columns B refer to yields expected under the best practices of management.]

Soil (type, phase, or land type)[1]	Crop productivity index[2] for —									
	Corn (100= 50 bu.)		Wheat (100= 25 bu.)		Oats (100= 50 bu.)		Barley (100= 40 bu.)		Lespedeza (100= 1.5 tons)	
	A	B	A	B	A	B	A	B	A	B
Armuchee silty clay loam, eroded steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Bolton loam, steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Decatur silty clay loam, severely eroded hilly phase	15	40	15	30	20	45	(4)	30	15	40
Bolton loam, eroded steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Colbert silty clay loam, eroded rolling phase	30	45	30	45	35	55	35	40	40	70
Talbott silty clay loam, eroded hilly phase	30	60	30	50	35	70	35	50	40	75
Bolton silty clay loam, severely eroded phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Waynesboro very fine sandy loam, eroded hill phase	30	65	30	65	35	70	35	50	40	75
Fullerton cherty clay loam, severely eroded phase	(4)	--	(4)	--	(4)	45	(4)	(4)	20	40
Fullerton cherty silt loam, hilly phase	(4)	55	30	50	30	55	25	55	30	75
Fullerton cherty fine sandy loam:										
Hilly phase	(4)	55	(4)	50	(4)	60	(4)	55	(4)	75
Eroded hilly phase	(4)	(4)	25	50	20	50	(4)	(4)	30	60
Fullerton cherty silt loam, eroded hilly phase	30	55	30	55	30	55	30	55	30	75
Sequoia shaly silty clay loam, severely eroded phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	20	35
Atkins fine sandy loam	(4)	[5]50	(4)	(4)	(4)	(4)	(4)	(4)	(4)	[4]75
Guthrie silt loam	(4)	[5]60	(4)	(4)	(4)	(4)	(4)	(4)	30	[5]50
Tyler very fine sandy loam	(4)	[5]50	(4)	(4)	(4)	(4)	(4)	(4)	20	[5]50
Clarksville fine sandy loam, eroded hilly phase	20	35	25	45	20	40	(4)	(4)	20	55
Clarksville cherty silt loam:										
Hilly phase	(4)	40	(4)	50	(4)	50	(4)	(4)	30	70
Eroded hilly phase	20	35	25	45	20	40	(4)	(4)	20	60
Clarksville cherty fine sandy loam:										
Hilly phase	(4)	30	(4)	40	(4)	35	(4)	(4)	(4)	55
Eroded hilly phase	18	30	20	30	18	30	(4)	(4)	20	50
Fullerton fine sandy loam, severely eroded hilly phase	20	40	16	40	16	40	(4)	(4)	25	65
Montevallo shaly silt loam, eroded rolling phase	20	35	20	30	25	50	(4)	(4)	20	60
Fullerton cherty silty clay loam, severely eroded hilly phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	20	60

FIFTH-CLASS SOILS

VERY POOR CROPLAND, VERY POOR TO POOR PASTURE LAND, BEST SUITED TO FOREST

Fullerton cherty clay loam, severely eroded hilly phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	20	30
Fullerton cherty silt loam:										
Steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Eroded steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Talbott silty clay loam, severely eroded hilly phase	20	50	(4)	30	20	45	(4)	35	15	35
Bolton silty clay loam, severely eroded steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Lehew stony very fine sandy loam, eroded hilly phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Hector stony fine sandy loam	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Hayter stony loam, severely eroded steep phase	(4)	(4)	(4)	(4)	(4)	(1)	(4)	(4)	(4)	(4)
Rough stony land (Talbott soil material)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Armuchee shaly silty clay loam, severely eroded phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Clarksville cherty clay loam, severely eroded hilly phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Clarksville cherty silt loam:										
Steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Eroded steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Fullerton cherty silty clay loam, severely eroded steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Montevallo shaly silty clay loam, severely eroded rolling phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Montevallo shaly silt loam, eroded hilly phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	20	55
Muskingum very fine sandy loam, hilly phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	30	70
Muskingum stony fine sandy loam, hilly phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Muskingum very fine sandy loam, eroded hilly phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	20	60
Armuchee silt loam, very steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Armuchee shaly silty clay loam, severely eroded steep phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Muskingum very fine sandy loam	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Rough gullied land (limestone residuum)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Lehew stony very fine sandy loam	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Montevallo shaly silty clay loam, severely eroded phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Muskingum stony fine sandy loam	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Muskingum very fine sandy loam, eroded phase	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Limestone outcrop	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Rough gullied land (shale and sandstone residuum)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Rough stony land (Muskingum soil material)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Sandstone outcrop	(4)	(4)	(4)	(4)	(5)	(4)	(4)	(4)	(4)	(4)

[1] Soils are listed in the approximate order of their general productivity under prevailing farming practices and their relative suitability for gr

[2] Soils are given indexes that give the acre yields to be expected of each crop in percent of the standard of reference. The standard repr without the use of fertilizer or other amendments on the more extensive and better soil types of those regions of the United States in which the c

[3] See footnote 4, table 8 (p. —).

[4] Crop is commonly not grown, and the soil is considered poorly suited to its production.

[5] These yields are with adequate artificial drainage, which is not feasible in all places.

[6] Crop is commonly not grown, but the soil is considered at least fairly well suited to its production.

clay or clay soils, hilly soils, or soils that contain enough stones to interfere seriously with cultivation are considered to have fair workability. Soils on which normal tillage operations can be performed only with great difficulty are considered to have poor workability. In this county such soils generally have slopes in excess of 25 percent or are so stony as almost to preclude tillage with ordinary implements. Soils with very poor workability are so steep or so stony, or both, that tillage is generally limited to the use of hand implements.

The six terms applied to conservability are also relative. The ease with which the content of available plant nutrients can be maintained at a high level, the ease with which runoff and consequent loss of soil material and water can be controlled, and the ease with which good tilth and good conditions for tillage can be maintained are the principal factors considered. Excellent conservability means that productivity and workability can be maintained with minimum intensity of management. Very good, good, and fair conservability represent soil conditions that require successively more intensive management for conservation of productivity, workability, or both, but both can generally be conserved under good management practices, and these are generally feasible under present conditions for crops requiring tillage. Poor conservability represents such soil conditions that productivity, workability, or both can be conserved when the soil is used for crops that require tillage only by intensive management practices, which are generally not feasible on most farms under present conditions. Very poor conservability represents the extreme of difficulty in conservation of productivity, workability, or both.

The soils are divided into two groups; one including those considered at least fairly well suited physically to crops as well as to pasture; the other, including those poorly suited physically to crops that require tillage.

The first group is subdivided into three subgroups, the limits between them being chosen to approximate the concept of excellent, good, and fair cropland, respectively. These three subgroups in decreasing order of physical suitability for agriculture are called First-, Second-, and Third-class soils.

The second group, which consists of soils that are poorly suited physically to the production of crops requiring tillage, is subdivided into two subgroups. One consists of soils that are at least fairly well suited physically to the production of permanent pasture; the other, of soils that are poorly suited to permanent pasture and are probably best suited to forest. The first of these is called Fourth-class soils; the second, Fifth-class soils.

Information obtained from farmers, soil surveyors, extension and experiment station workers, and others was used in placing the soils in these five physical land classes. Comparisons were made among the soils, considering productivity, workability, and conservability. For example, a farmer knows that some soils on his farm are better suited to agriculture than are others. By comparisons of this nature within farms and among farms the soils are placed in the approximate order of their physical suitability for agriculture and appear in that order in table 9. The limits selected within this ranking for separation of the soils into the five physical land classes are approximations, and the

soils that appear adjacent to each of these limits in the table are marginal between the two classes on either side of the limit.

It was assumed that in agriculture under present conditions in this area soils that are only moderately well suited physically both to crops requiring tillage and to pasture are better suited to agriculture than are soils poorly suited to crops but well suited physically to pasture. This assumption was made because soils that are well suited physically to crops are limiting on more farms than are soils that are well suited physically to pasture. If livestock should become more important in the agriculture of the area, this assumption may become invalid.

The five physical land classes are defined in terms of the relative physical suitability of the soils for agriculture under present conditions. Within that definition, however, the range of relative physical suitability for crops requiring tillage and for permanent pasture is given.

FIRST-CLASS SOILS

The First-class soils are physically very good for agriculture—they are good to excellent for crops requiring tillage and are good to excellent for permanent pasture. All are relatively well supplied with plant nutrients when compared with other soils of the county, but even the most fertile is responsive to amendments for some crops. All are well drained, yet their physical properties are such that they retain moisture well. Good tilth is easily obtained and maintained, and the range of moisture conditions suitable for tillage is comparatively wide. The soils are relatively well supplied with organic matter. The physical properties favor normal movement of air and moisture, and roots penetrate the soil easily.

None of these soils is characterized by any prominent adverse soil condition. They are almost free of stones, the relief is favorable to soil conservation and tillage, and none is severely eroded or highly susceptible to erosion. The productivity is high for many crops, and the problem of conservation of soil fertility and of soil material itself is relatively simple under common farming practices. All are well suited physically to most of the exacting and intensive crops commonly grown in the locality.

SECOND-CLASS SOILS

The Second-class soils are physically good for the agriculture of the county—they are fair to good for crops requiring tillage and fair to excellent for permanent pasture. All are at least moderately productive of most of the crops commonly grown. Their physical properties are at least moderately favorable for tillage, maintenance of good tilth and normal circulation, and retention of moisture. None occupies slopes greater than 12 to 15 percent, none is sufficiently stony to interfere seriously with tillage operations, and none is severely eroded. Each is moderately deficient in one or more characteristics that contribute to productivity, workability, or conservability, but none is so seriously deficient in any characteristic as to make it poorly suited physically to use for crops requiring tillage.

Deficiencies vary widely among the soils. Some are fertile but are sloping and moderately eroded; others are almost level and uneroded but relatively low in content of plant nutrients. Because of the many

different kinds of soils included, management requirements range widely. The soils of the group are relatively similar in their suitability for agriculture, although the management practices by means of which the benefits of their suitability may be realized may differ greatly.

THIRD-CLASS SOILS

The Third-class soils are physically fair for the agriculture of the county—they are poor to fair for crops requiring tillage and fair to very good for permanent pasture. Each is characterized by workability, conservability, or productivity, one of which, or a combination, is sufficiently poor to limit definitely the physical suitability of the soil for crops requiring tillage. None of these conditions is so limiting that the soil is poorly suited to such crops. These soils are better suited physically to crops requiring tillage than are the Fourth-class soils and are less well suited to these crops than are the Second-class soils. One or more of the conditions of low content of plant nutrients; low content of organic matter; low water-holding capacity; undesirable texture, structure, or consistence; strong slope; stoniness; and inadequate natural drainage limit the physical suitability for crops that require tillage. Because of the diversity of characteristics among the soils of this group, the management requirements range widely.

FOURTH-CLASS SOILS

The Fourth-class soils are physically poorly suited to crops requiring tillage and are poor to very good for permanent pasture—they are poor soils for agriculture, mainly because of the limited number of uses to which they are well suited. Some may be the most important ones on some farms, however, where soils that are well suited to permanent pastures are in great demand.

Each soil of this group is so difficult to work or so difficult to conserve, or both, that management practices necessary for their successful use for crops requiring tillage are not feasible on many farms under present conditions. On some farms, however, soils well suited to crops may be so limiting that it is good farm management to practice the intensity of soil management necessary for the successful use of Fourth-class soils for these crops. They are generally used for pasture on farms where adequate soils well suited to crops are available. A considerable acreage is used for crops, mainly on farms where soils better suited to the production of crops exist in acreages too small to satisfy the needs of the farm unit. The intensity of management practiced on the areas so used is generally inadequate for good soil conservation. As on the Third-class soils, management requirements both for crops requiring tillage and for pasture vary widely among the Fourth-class soils.

FIFTH-CLASS SOILS

Fifth-class soils are very poorly suited to the agriculture of the county—they are very poor for crops requiring tillage and are poor to very poor for permanent pasture. Each is so difficult to work, so difficult to conserve, or so low in productivity that it is generally not feasible to apply the intensity of management necessary for its successful use for tilled crops. Each is so low in content of plant nutrients or has such poor moisture relations, or both, that common pasture plants

produce very little feed. These soils are apparently best suited to forest or similar uses under present conditions. Existing conditions of the locality or of the farm unit may require the use of some of the soils of this class for pasture or for crops, despite the fact that they are poorly suited to such uses under present conditions. A few soils have been used successfully for crops by some farmers who have applied special management systems.

Following is a grouping of the soils according to physical land class with the acreage for each:

First Class:	Acres
Abernathy silt loam	192
Cumberland silt loam	64
Decatur silty clay loam, eroded undulating phase	384
Dewey silty clay loam, eroded undulating phase	128
Emory silt loam	640
Sloping phase	512
Etowah silt loam	64
Hayter loam	256
Huntington silt loam	128
Total	2,368

Second Class:	
Bolton loam, eroded rolling phase	1,792
Bruno fine sandy loam	832
Cumberland silty clay loam, eroded sloping phase	128
Decatur silty clay loam, eroded phase	768
Dewey silty clay loam, eroded phase	384
Fullerton fine sandy loam	320
Eroded phase	4,608
Undulating phase	128
Fullerton silt loam, eroded phase	768
Greendale loam	640
Sloping phase	768
Greendale silty clay loam	128
Hayter loam, eroded sloping phase	320
Holston very fine sandy loam	64
Jefferson stony fine sandy loam, eroded phase	128
Leadvale silt loam	384
Lindside silt loam	1,984
Ooltewah silt loam	320
Pope fine sandy loam	320
Roane silt loam	576
Sequatchie fine sandy loam	448
Sequoia silty clay loam, eroded undulating phase	448
Talbott silty clay loam, eroded undulating phase	192
Waynesboro very fine sandy loam:	
Eroded phase	64
Eroded sloping phase	192
Total	16,704

Third Class:	Acres
Bolton loam	640
Eroded phase	3,520
Bruno loamy fine sand	320
Clarksville cherty fine sandy loam, eroded phase	1,472
Clarksville cherty silt loam	384
Clarksville fine sandy loam, eroded phase	1,472
Colbert silt loam	64
Decatur silty clay loam:	
Eroded hilly phase	192
Severely eroded phase	448
Fullerton cherty fine sandy loam	256
Eroded phase	1,792
Fullerton cherty silt loam	256
Eroded phase	1,024
Fullerton fine sandy loam:	
Eroded hilly phase	3,968
Hilly phase	1,024
Fullerton silt loam:	
Eroded hilly phase	832
Hilly phase	320
Greendale silty clay loam, sloping phase	128
Hayter stony loam, eroded phase	256
Holston very fine sandy loam, eroded sloping phase	128
Jefferson stony fine sandy loam:	
Eroded sloping phase	896
Sloping phase	128
Leadvale silt loam, sloping phase	1,024
Philo fine sandy loam	1,664
Sequoia silty clay loam, eroded phase	2,432
Talbott silty clay loam, eroded phase	960
Total	25,600

Fourth Class:	
Armuchee silt loam	1,152
Steep phase	5,312
Armuchee silty clay loam:	
Eroded phase	2,432
Eroded steep phase	1,856
Atkins fine sandy loam	256
Bolton loam:	
Eroded steep phase	1,216
Steep phase	512

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Fourth Class—Con.	Acres
Bolton silty clay loam, severely eroded phase	1,472
Clarksville cherty fine sandy loam:	
Eroded hilly phase	2,816
Hilly phase	5,632
Clarksville cherty silt loam:	
Eroded hilly phase	1,024
Hilly phase	1,088
Clarksville fine sandy loam, eroded hilly phase	896
Colbert silty clay loam, eroded rolling phase	320
Decatur silty clay loam, severely eroded hilly phase	64
Fullerton cherty clay loam, severely eroded phase	320
Fullerton cherty fine sandy loam:	
Eroded hilly phase	4,032
Hilly phase	2,304
Fullerton cherty silt loam:	
Eroded hilly phase	3,584
Hilly phase	1,920
Fullerton cherty silty clay loam, severely eroded hilly phase	448
Fullerton fine sandy loam, severely eroded hilly phase	1,088
Guthrie silt loam	64
Hayter stony loam:	
Eroded hill phase	512
Eroded steep phase	576
Hill phase	320
Steep phase	256
Hilly stony land:	
Colbert soil material	2,752
Talbott soil material	8,768
Melvin silt loam	64
Montevallo shaly silt loam:	
Eroded rolling phase	448
Eroded undulating phase	192
Rolling stony land (Talbott soil material)	4,864
Sequoia shaly silty clay loam, severely eroded phase	768
Talbott silty clay loam, eroded hilly phase	448
Tyler very fine sandy loam	64
Waynesboro very fine sandy loam, eroded hill phase	192
Total	60,032

Fifth Class:	Acres
Armuchee shaly silty clay loam:	
Severely eroded phase	3,136
Severely eroded steep phase	3,328
Armuchee silt loam, very steep phase	2,176
Bolton silty clay loam, severely eroded steep phase	640
Clarksville cherty clay loam, severely eroded hilly phase	960
Clarksville cherty silt loam, eroded steep phase	1,152
Steep phase	2,944
Fullerton cherty clay loam:	
Severely eroded hilly phase	1,984
Fullerton cherty silt loam:	
Eroded steep phase	2,112
Steep phase	2,560
Fullerton cherty silty clay loam, severely eroded steep phase	768
Hayter stony loam, severely eroded steep phase	448
Hector stony fine sandy loam	192
Lehew stony very fine sandy loam	4,032
Eroded hilly phase	576
Limestone outcrop	1,664
Montevallo shaly silt loam, eroded hilly phase	576
Montevallo shaly silty clay loam:	
Severely eroded phase	448
Severely eroded rolling phase	256
Muskingum stony fine sandy loam	2,496
Hilly phase	1,024
Muskingum very fine sandy loam	10,368
Eroded phase	1,664
Eroded hilly phase	1,984
Hilly phase	1,344
Rough gullied land:	
Limestone residuum	3,200
Shale and sandstone residuum	3,328
Rough stony land:	
Muskingum soil material	8,128
Talbott soil material	8,640
Sandstone outcrop	1,664
Talbott silty clay loam, severely eroded hilly phase	64
Total	73,856

LAND USE AND SOIL MANAGEMENT

Following is a brief explanation of some of the principles of land use and soil management and a statement of the major requirements for good management of the soils of the county. This section also supplements the definition of good management for columns B of the tables of estimated yields (table 8) and of productivity ratings (table 9).

The term "land use" refers to such broad farm uses as for (1) crops that require tillage; (2) permanent pasture; and (3) forests. The term "soil management" refers to (1) choice and rotation of crops; (2) application of soil amendments—lime, commercial fertilizers, manure, and crop residues; (3) tillage practices; and (4) engineering practices for the control of water on the land.

The farmer who attempts to readjust the use and management of his soils is confronted with a number of problems over some of which he has no control. Among these are (1) the size and type of farm; (2) the physical character of the land, including the pattern of soils on the farm; (3) the surrounding social and economic conditions, as transportation, market, church, and school facilities; (4) the immediate demand for a cash income to meet taxes, indebtedness, support of family, and other expenses; (5) the relation between prices of farm products and other commodities; (6) the farm operator's facilities and resources for operating purposes, including buildings, equipment, seed, kind and number of livestock, cash, credit, and other items; (7) his ability, preferences, and other characteristics; (8) community cooperation with respect to drainage, water disposal, marketing, buying, and other operations; and (9) numerous factors, as farm tenure, labor conditions, and health.

A full solution of land use and management problems requires individual-community-State-national action, embracing all the problems and influences that affect agriculture. A farmer can make only those adjustments toward better management that are possible within his limited financial and personal ability. In the suggestions for management practices for the various soils, it is recognized that certain of these may not be feasible for some farmers under present conditions.

Management requirements vary among different uses of the same soil as well as among different soils in the same use. For each group the requirements are discussed with respect to crops that require tillage and to permanent pasture.

As management requirements vary among crops requiring tillage on the same soil, they are discussed for these crops in terms of a rotation or rotations considered well suited to the soils. The management of the soil for one crop of the rotation generally has an effect on the production of other crops in the rotation. Management requirements of the soil for each crop, therefore, are dependent not only on the characteristics of the soil and of the crop but also on the management that has been practiced on other crops of the rotation.

Experimental data on which to base recommendations for the use or management of many of the soils are not entirely adequate, and recommendations for best use and best management of a soil in a particular place involve a consideration of so many conditions that exist on the particular farm that they cannot be made in a general

discussion of soils of a large area. The material, therefore, in this section is limited to a discussion of the deficiencies of soils, in order that persons who have the other necessary information may interpret them into recommendations for particular areas.

Management practices that are good under conditions that exist on many farms are suggested to serve as a guide for persons who will interpret the information contained in this section. The suggested management practices are to be used as the definitions of management for columns B of the tables of estimated yields and productivity ratings. They represent one or more particular kinds of management that are good, but many different combinations in various intensities of application can be used in most cases to attain the same objective of production. The proper choice depends upon conditions of the farm as a unit. For example, nitrogen may be maintained by the use of legumes, manure, or commercial fertilizers, or combinations of the three. The best method for maintaining nitrogen depends on the farm as a business as well as on soil conditions.

The soils have been grouped elsewhere according to their relative physical suitability for general use. In this section they are placed in 13 separate groups on the basis of their management requirements. Although it is necessary to assume a use in order to discuss specifically the management requirements of a soil, the grouping on these two bases should not be confused. The soils within one of the physical land classes or use groups vary widely in their management requirements and responses. Soils may be similarly suitable physically for the agriculture of the county, but the management practices necessary to attain and maintain that suitability may be quite different among them because the deficiencies of the several soils of the group are different. Conversely, soils of similar management requirements may have a different physical suitability for farm use. Soil characteristics that have little influence on management requirements for a particular use may have a great influence on the physical suitability of the soil for that use. For example, stoniness may have a greater influence on the physical suitability of a soil for crops requiring tillage than it has on the management requirements of the soil to produce those crops. In most cases, however, the soils of each management group are not widely separated in physical suitability for use in the present local agriculture.

Only soils of the first four physical land classes are discussed with respect to management requirements. Fifth-class soils are so poorly suited either to crops or to pasture that it is not considered necessary to suggest management requirements for them. Feasible management practices generally would not materially increase their normally low productive capacity either for crops requiring tillage or for pasture. The mapping units of the Fifth-class soils are, by a process of elimination, relegated to forest use, even though they are less productive of forests than most of the soils in the 13 groups of the first four classes. The management of these soils is, then, concerned largely with forestry problems; and forest management is considered in the section on Forests.

GROUP 1

Group 1 consists of the silt loams of the Abernathy, Ooltewah,

Huntington, and Lindside series. These soils are fertile, easily worked, and are generally not appreciably subject to accelerated erosion. They are the soils best suited to intensive and continuous production of certain important crops.

These nearly level soils exist on first bottoms or in depressions of the uplands and receive depositions of alluvial materials periodically. They have a relatively high content of organic matter and plant nutrients added to the surface periodically by flooding. Their physical condition is very good for the maintenance of good tilth and for normal retention and movement of water in the upper parts of the soil. External drainage is slow; internal drainage is relatively rapid in the Huntington and Abernathy soils and is slow in the Lindside and Ooltewah.

The soils are subject to inundation in spring and during periods of heavy rainfall, and are not so well suited to perennial and winter annual crops as are most soils of the well-drained uplands. They are exceptionally well suited to corn and to hay crops, including red clover and timothy, and are excellent soils for pasture. They are not so well suited to small grains, because of the tendency of the grain to lodge. Lindside and Ooltewah silt loams are slow to become suitable for tillage in spring and present some problem of drainage.

No special practices of tillage or cropping are necessary for the control of too rapid runoff on these soils. There is some danger of scouring during floods on the Huntington and Lindside soils, and for this reason it is advisable to plow in spring rather than in fall. Artificial drainage would improve the Lindside and Ooltewah soils for most crops, but it is generally difficult to establish because of lack of proper outlets for the drains.

Permanent pastures are very good without special management practices. Phosphorus is the principal plant nutrient that may be limiting. Pastures should be grazed or clipped closely to favor the growth of leguminous pasture plants at the expense of grasses. Heavy grazing is generally less harmful to pastures than undergrazing.

These soils can be used for intertilled crops each year and will maintain production at a high level for considerable periods without amendments, although precautions taken to maintain the content of plant nutrients and organic matter generally increase production. Corn followed by a cover crop, as crimson clover or hairy vetch in fall, to be plowed under as green manure in spring, is considered a good cropping system. Production can be maintained at a relatively high level without amendments under such cropping, but yields of corn may be increased considerably by the use of light or moderate applications of potassium and phosphorus to the cover crop.

Corn followed by 1 or 2 years of red clover and grass hay is also a good cropping system for these soils. Fertilization of the clover seeding with moderate to light applications of potassium and phosphorus would probably improve production of both hay and corn. Alfalfa can be grown on the Huntington or Abernathy soils instead of red clover, and in most places it would probably be improved by moderate applications of lime on the Abernathy soil at seeding. Alfalfa is not well suited to Lindside or Ooltewah soils.

Late-planted vegetables do well on these soils, particularly the Hunt-

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ington and Abernathy. Vegetable crops each year followed by a leguminous winter cover crop to be turned under in spring produce well if well managed in other respects. Experience in other areas indicates that such crops respond well to heavy applications of complete fertilizer.

GROUP 2

Group 2 includes Bruno, Sequatchie, Pope, and Philo fine sandy loams, Bruno loamy fine sand, and Roane silt loam. Management differs from soils of group 1 principally in the greater difficulty with which plant nutrients are maintained at a high level.

These are well-drained or imperfectly drained soils of first bottoms, low terraces, and depressions. All except the Sequatchie soil receive alluvial deposits periodically, although areas along the Holston River below Cherokee Dam are now subject to only very occasional and limited flooding. All are moderately low in nitrogen, phosphorus, and potash as compared with group 1. All except the Bruno soils are low in lime. None is subject to appreciable accelerated erosion. All have highly desirable physical conditions for the maintenance of good tilth. The Pope, Sequatchie, Bruno, and Roane soils are well drained; the Philo imperfectly.

Most of these soils are at least moderately well suited physically to vegetables, corn, and hay crops. They are generally less well suited to perennials or winter annuals, although small grains are moderately productive under good management. Management practices that aid in maintaining the content of organic matter and plant nutrients at levels adequate for good production should receive first consideration.

Intertilled crops, as vegetables or corn, can be grown successfully year after year on most of these soils if other management requirements are met. It is generally advisable to grow a winter-legume cover crop, as crimson clover or hairy vetch, after each such crop to aid in the maintenance of organic matter and nitrogen. The soils, except the Bruno types, are moderately to strongly acid, and moderate applications of lime at relatively short intervals should be made for good results in such a cropping system. Heavy applications of a complete fertilizer that carries a relatively high proportion of nitrogen and potash have given good results for vegetable crops in other areas. Most of the nitrogen and organic matter necessary can be obtained from the cover crop if it is turned under in spring as a green manure. It may be desirable to apply lime under the cover crop and phosphorus and potash under the vegetable crops and to depend upon the residual effects of each for the crop to follow. Manure is especially beneficial, and where it is applied the quantity of nitrogen and potash in commercial fertilizers used may be reduced.

A common rotation of the common field crops and one that appears to be well suited to these soils is corn followed by small grain to be harvested in spring and lespedeza to be harvested the following fall. Moderate applications of lime under the small grain-lespedeza seeding would benefit the crops of the rotation, and moderate applications of potassium and phosphorus once in the rotation should prove beneficial. Manure is highly beneficial and can replace part or all of the potash of commercial fertilizer. Red clover can replace lespedeza in the same

rotation, and alfalfa can be used in a longer rotation on the well-drained soils, but it requires heavier applications of lime and potassium than the other hay crops suggested.

Frequent moderate applications of fertilizers, rather than heavy applications at long intervals, are desirable on these soils. Liming is generally not necessary on the Bruno soils.

Pastures commonly consist of relatively undesirable plants on these soils unless they are adequately fertilized. Moderate applications of lime and phosphorus every 3 or 4 years are desirable. Potassium may be supplied in adequate quantities if droppings are scattered, but if potash deficiency develops it may be necessary to supply it. Very close grazing is more harmful on these soils than on those of group 1, but undergrazing should also be avoided. Clipping of pasture should aid in controlling pasture weeds and encourage the growth of white clover.

No special practices of tillage or cropping are necessary for the control of runoff, but the soils of the first bottoms may scour during floods and should be plowed in spring instead of fall unless a cover crop is grown. Artificial drainage would improve Philo fine sandy loam but it is generally difficult to establish. Most of these soils can be tilled throughout a relatively wide range of moisture conditions.

GROUP 3

Group 3 includes the eroded, eroded sloping, and sloping phases of Jefferson stony fine sandy loam; Holston very fine sandy loam and its eroded sloping phase; and Montevallo shaly silt loam, eroded undulating phase.

The soils of the Jefferson series consist of local alluvial-colluvial accumulations at the foot of slopes. The Holston soils occupy stream terraces, and the Montevallo has developed from materials weathered from shale in place. All these soils are siliceous and are low in fertility and general productivity of agricultural crops. Naturally the vegetative cover is relatively sparse where the soils have not been treated and otherwise well cared for. The characteristic light vegetative cover and the siliceous character of the soil material partly account for the high susceptibility to erosion. The slope gradient of the soils is rather mild, rarely exceeding 12 percent. Some of the soils are stony, otherwise they are tilled with relative ease.

The low natural fertility of these soils suggests the need of rather liberal uses of complete fertilizers, although there is some evidence that the Montevallo soils do not have a high requirement for potash. They are all strongly or very strongly acid, and rather liberal applications of lime are necessary in order to support a suitable rotation of crops, particularly legumes. Applications of manure are very effective on all soils of this group. These soils are not well adapted to such exacting crops as alfalfa, red clover, tobacco, corn. This should be kept in mind in planning the choice and rotation of crops. Because of low fertility and high susceptibility to erosion, the sequence of crops should include as many legumes as feasible, and the nature of the soils suggests the need of close-growing crops a considerable part of the time.

These soils are not considered so well suited for permanent pasture

as are most of the soils developed from limestone materials. With liberal applications of lime and fertilizer, particularly phosphates, permanent pastures can be produced at least fairly satisfactorily.

GROUP 4

Group 4 includes Greendale loam, Greendale silty clay loam, and Leadvale silt loam and their sloping phases. All these soils have developed from colluvial materials accumulated at the foot of slopes and occupy mild slopes, rarely exceeding 12 percent. They are virtually stone-free and are characterized by fair to very good tillage qualities. There are some differences among the soils, however, as to ease of tillage. Tilth conditions are a little less desirable on the Greendale soils. The materials from which they have developed originated chiefly from siliceous limestone; the parent materials of the Leadvale soils originated as the weathered products of shale. All the soils are adequately drained for the production of crops requiring tillage, and all are relatively low in natural fertility. They are only moderately productive of the important crops, although very responsive to soil amendments, including lime, manure, and complete commercial fertilizers. All are strongly to very strongly acid.

Although these soils have rather mild slopes, the control of water is not a simple matter. The difficulty of properly controlling the water is chiefly due to the fact that these soils occupy positions at the foot of rather long slopes and receive considerable runoff. Water control on these soils, therefore, depends to a considerable extent on the control of water on the slopes above.

Occurring in rather small areas or long narrow strips at the base of slopes, these soils should be used and managed along with others that are closely associated. The soils of this group might be considered well to fairly well suited to crops requiring tillage. Careful planning is required. This applies particularly to the choice and rotation of crops and the use of amendments. The physical requirements of these soils, including natural low fertility and the need for proper control of the water that falls and accumulates upon them, suggest the need of rather long rotations that will provide for the production of close-growing crops—particularly legumes. For this sort of rotation, where lime has not been used previously, 2 or 3 tons of ground limestone an acre are needed as an initial application. Manure is very effective on all these soils, and either liberal applications of complete fertilizers or liberal applications of lime and phosphates along with carefully planned rotations, including legumes, would be effective measures toward increasing yields.

Although their suitability to more intensive use precludes utilization of these soils for pasture, they are well suited physically to this use. Their low natural fertility makes necessary the use of lime, phosphorus, and possibly potash in moderate quantities to insure good growth of pasture plants, especially legumes and the better grasses. Although the use of amendments and controlled grazing are largely effective in eradicating weeds, occasional clipping for this purpose may be desirable. Initial seedings can well be made with a contour seeder rather than by the conventional method of plowing and seeding, but on established pasture special practices for runoff control are generally unnecessary

except that careful control of grazing during periods of adverse moisture conditions may be required.

GROUP 5

Group 5 includes the eroded undulating phases of Dewey and Decatur silty clay loams; Etowah and Cumberland silt loams; Emory silt loam and its sloping phase; Hayter loam and its eroded sloping phase; Hayter stony loam, eroded phase; and the eroded phase of Waynesboro very fine sandy loam. These soils are physically well suited to the production of intertilled crops. They are all well drained, relatively fertile, and are among the more productive soils of the important crops of the region. All have mild or very mild slopes. Slopes in this group rarely exceed 7 percent, although in Emory silt loam, sloping phase, and the Waynesboro soil they occasionally exceed 12 percent. The soils are virtually stone-free, and tilth conditions are generally good to very good, although the silty clay loam types of the Decatur and Dewey series are somewhat difficult to till except within a rather narrow range of moisture conditions. At least a part of the parent material of all these soils originated from the weathered products of limestone, although the parent material of the Waynesboro and Hayter soils has been contributed principally through the weathering of sandstone. The Decatur and Dewey soils have developed from the weathered products of limestone in place, whereas the rest have developed from parent material that has been water-shifted in one form or another.

All the soils of this group are medium to very strongly acid and they respond effectively to rather heavy applications of ground limestone. Although they are relatively fertile and productive, it is usually profitable to use rather liberal quantities of fertilizer. In planning choice and rotation of crops, it should be kept in mind that these soils are well to very well suited to such exacting crops as alfalfa, red clover, and tobacco. If the crop rotation includes the growing of legume and sod-forming crops much of the time, it might prove advisable to use most of the commercial fertilizer in the form of phosphates along with ample applications of ground limestone. The quantities and kinds of amendments used will depend upon many factors, and this should vary considerably among the many different farms.

Grass-legume pastures are very well suited to this group, especially if moderate to large quantities of phosphorus and lime are applied at moderately long intervals. Probably the scattering of droppings will provide sufficient potassium, although some additional quantities from commercial fertilizer may be required. Controlled grazing and the use of amendments is largely effective in weed eradication, but occasional mowings for this purpose may be advisable. Special practices for conserving soil moisture and material are not ordinarily required on these soils under pasture, although the control of grazing during extremely wet or dry periods is advisable to prevent injury to pasture stands and soil tilth conditions—hence to the absorptive capacity. Widely spaced walnut and locust trees for shade may be beneficial to pastures.

GROUP 6

Group 6 includes the eroded sloping phases of Waynesboro very fine sandy loam and Cumberland silty clay loam; the eroded rolling phase

of Bolton loam; and the eroded phases of Dewey and Decatur silty clay loams. All these soils are well suited to a rotation of crops including those requiring tillage. They are fertile and productive of the important crops; occupy rather mild slopes, rarely exceeding 12 percent; are virtually stone-free; and fair tilth conditions can be maintained under reasonable care and management. Although the slopes are relatively mild, a considerable part of the surface layer of all these soils has been removed by accelerated erosion, which increases the difficulty of water control. This condition also tends to narrow the range of moisture conditions within which the soils may be tilled satisfactorily and emphasizes the importance of careful planning, particularly as to choice and rotation of crops.

The general character of this group suggests the need of rather long, well-planned crop rotations that will provide for the production of close-growing crops, particularly legumes, much of the time. This kind of rotation is very responsive to adequate applications of lime and phosphorus. On farms where it is not advisable to provide such a place for sod and legume crops in the rotation, the need for increased quantities of manure and complete commercial fertilizers will be much greater.

Tillage operations should be with the contour as much as practicable, and large turning plows should be used on the silty clay loams of the Dewey, Decatur, and Cumberland series only after very thorough consideration. Terracing may be a means of conserving soil moisture and soil material on some areas, but to be effective, terraces must be carefully planned, well built, and properly maintained. Occasional gullies can be stabilized with suitable dams—either permanent or temporary, depending upon size of gully, availability of materials, and other factors.

The soils of this group are generally well suited to pasture, although some difficulty in maintaining grass cover on the Bolton soil may be experienced because its friable puffy consistence apparently is responsible for considerable damage to grass by freezing and heaving. Pasture management requirements are essentially the same as in group 5. The use of lime, phosphorus, and possibly potash; scattering of droppings; mowing to eradicate weeds and brush; and controlled grazing are among the important management requirements. Pasture seedings can well be made with a contour seeder, but after stands become established special runoff control measures other than regulating grazing during periods of adverse moisture conditions are not ordinarily needed.

GROUP 7

Group 7 includes Colbert silt loam and the eroded undulating phases of Talbott and Sequoia silty clay loams. These soils are fine-textured, moderately fertile, and have mild slopes (0 to 5 percent). They are somewhat difficult to till and are moderately difficult to maintain in good tilth. Water penetrates the soil rather slowly, and moisture movement is moderately slow. They are generally deficient in phosphorus but not so deficient in lime and potassium as many of the soils of the county, although probably somewhat more so than the soils of the groups previously discussed. They are generally somewhat deficient in nitrogen and organic matter. Two of the main management problems are maintenance of good tilth and improvement of the physical condition of

the soil for absorption and maintenance of an adequate supply of water for plant growth.

These soils are limited in their suitability for crops, particularly Colbert silt loam. Vegetables are poorly suited to them, but hay and pasture plants produce fairly well.

Deep-rooted legume crops can be used effectively on these soils to improve the physical condition and to help maintain organic matter and nitrogen content; alfalfa, sweetclover, and sericea lespedeza are important crops suited to this purpose. Green-manure crops, including crimson clover, vetch, and small grains also are useful for the same purposes. A rotation of a row crop, small grain, and alfalfa is suitable for these soils after they have been built up to a relatively high state of productivity. Red clover can be used in place of alfalfa if a shorter period of hay is desired. Row crops can probably be grown safely once in 3 or 4 years without injury to the soil.

Phosphorus is the chief limiting nutrient and should be applied in large quantities at relatively long intervals under the legume in the rotation. Lime in moderate quantities at fairly long intervals, preceding the seeding of the legume in the rotation, is necessary for success with the crop and increases the yields and improves the quality of other crops. Manure is an effective source of nitrogen and potassium and also serves to increase the organic matter and to improve the tilth and water-absorbing properties of the soil.

The range of moisture content within which tillage can be accomplished without impairing good tilth is rather narrow. Contour tillage aids materially in conserving soil moisture and soil material. Terracing is not a desirable practice on these soils nor is strip cropping except on some of the longer slopes. Fall plowing to provide opportunity for improvement of tilth is a good practice, provided cover can be established to prevent excessive runoff and consequent loss of soil moisture and soil material.

Pastures are generally fair, but for good yields they require moderate to heavy applications of lime and phosphorus at relatively long intervals. Pastures are harmed more by undergrazing than by overgrazing, but too heavy grazing in the wet spring months may result in damage to soil tilth and injury to the pasture stand. Mowing will do much to control weeds and brush. Scattering of droppings will likely maintain potassium supplies, although some potash from commercial fertilizer may be needed at rather long intervals. Shading by widely spaced walnut or locust trees may be beneficial to some pastures.

GROUP 8

Group 8 includes the eroded phases of Talbott and Sequoia silty clay loams and the severely eroded phase of Decatur silty clay loam. They are heavy-textured, relatively shallow, and moderately fertile, with rolling relief (5 to 12 percent), and are characterized by occasional outcrops of limestone bedrock, except on the Decatur soil, which is somewhat deeper than the other two. As a group they differ from soils of group 7 chiefly in having stronger slopes.

Rotations that include intertilled crops as little of the time as is feasible from the standpoint of good farm management are best suited to these soils. They can be maintained in a productive condition and

protected from erosion in a rotation that includes a row crop once in 5 to 6 years. Rotations such as those suggested for the soils of group 7 may be used by allowing the hay or pasture crop to remain on the soil 2 or 3 years longer. Alfalfa is well suited to this rotation, provided plant nutrient supplies are maintained at a fairly high level.

Fertilization of the rotation similar to that suggested for the rotations of group 7 is well suited to these soils, but potash and nitrogen may be limiting in more places. Applications of manure before seeding the legumes are highly beneficial in supplying nitrogen and potash and also in helping to maintain or improve good physical condition of the soils by increasing organic matter.

Contour tillage is essential to good management. The soils should be bare of vegetation as little of the time as feasible, and if tilled in fall, they need cover crops for winter protection and to supply organic matter when turned under in spring. Restricting tillage to a narrow range of favorable moisture conditions will aid in preserving good tilth. Terracing is not a good practice on these heavy-textured shallow soils, but on the longer slopes strip cropping may be effective in conserving soil moisture and soil material.

Good pasture management involves about the same practices as suggested for the soils of group 7. These include moderate to heavy applications of lime and phosphorus at relatively long intervals, clipping ungrazed herbage, scattering droppings, and careful control of grazing. Undergrazing should be avoided as much as overgrazing.

Under good rotations that receive adequate amendments and where good tillage practices are followed, terraces are generally not needed, but they may be used effectively on some of the longer slopes to aid in conserving water and soil material where intertilled crops are grown frequently in the rotation. Strip cropping may be useful on some soils for the same purposes. Winter cover crops are an important means of conserving moisture and soil material where rotations that include row crops are used.

Pastures on these soils are generally poor except where well managed. Moderate quantities of lime at relatively short intervals after an initial heavy application are required, and phosphorus in relatively large quantities also is needed. An application of potash will aid in the establishment of good pastures, after which scatterings of droppings may provide sufficient plant nutrients. Initial seeding of pasture and applications of fertilizer can well be made with a contour seeder, but well-established properly grazed pastures will probably require no special practices for conserving soil material and water. Both undergrazing and overgrazing are detrimental to pastures. Occasional mowing will help to control weeds and brush.

GROUP 9

Group 9 includes the following soils: In the Fullerton series the fine sandy loam, and its eroded and undulating phases; the cherty fine sandy loam and its eroded phase; the cherty silt loam and its eroded phase; and the silt loam, eroded phase; and in the Clarksville series the fine sandy loam, eroded phase; cherty fine sandy loam, eroded phase; and cherty silt loam. These are light to medium-textured soils of low to medium fertility on rolling uplands. All have slopes of 5 to 12 percent

except Fullerton fine sandy loam, undulating phase, and small areas included in several of the other types and phases that have slopes of less than 5 percent. These soils are easily maintained in good tilth and can be worked over a rather wide range of moisture conditions, but the chert on the surface and in the profiles of the cherty types and phases interferes with tillage operations.

The supply of lime, nitrogen, phosphorus, and potash is likely to be limiting to good plant growth on most of these soils. They have a moderate but not serious problem of runoff control, the loss of soil moisture and material generally being less than on the heavier limestone soils, as those in group 6 on similar slopes. Moderate susceptibility to erosion, however, together with the rather rapid loss of water through percolation, especially on the fine sandy loam types, makes moisture conservation important. Insofar as good farm management will permit, soil management practices for maintaining or increasing the supply of lime, phosphorus, potassium, and organic matter and for regulating runoff are required by the soils of this group.

The choice and rotation of crops should provide a leguminous crop at moderately short intervals. The soils can be conserved if row crops are grown not oftener than once in 4 years on most of them. A rotation of a row crop, small grain, and lespedeza and grass for 1 or 2 years should be satisfactory. Alfalfa or red clover may be used instead of lespedeza and grass, but they require heavier fertilization and liming than lespedeza. Vegetables, corn, and tobacco are among the row crops suited to the soils. The rotation can be shortened somewhat by the use of winter-legume green-manure crops to be plowed under before the intertilled crop.

A moderate application of phosphorus and potash at relatively short intervals is required for good yields of most crops. The small grain and lespedeza or small grain and clover crops respond well to moderately light applications of potash, and there is some residual effect on the row crop that follows. Probably 100 pounds of potash an acre divided between the hay and corn crop is adequate, and in places less than that may be sufficient. The application of the equivalent of 300 pounds of 20-percent superphosphate and 1½ to 3 tons of ground limestone just before the legume in a 4-year rotation will probably supply the requirements of most crops in the rotation for those amendments. Tobacco and vegetable crops respond readily to moderate to heavy applications of high-analysis complete fertilizers, the quantity that can profitably be used being determined to a considerable extent by the prices of those crops.

Green-manure crops, including crimson clover, vetch, and small grains turned under preceding the tobacco and vegetables, are good sources of organic matter and nitrogen and also are useful in controlling runoff in winter. All crops in a rotation respond well to applications of barnyard manure, inasmuch as it tends to increase the humus content and moisture retaining properties of the soils as well as serving as a source of nitrogen and potassium. Alfalfa may need small applications of boron in addition to the other common amendments. The quantities of all amendments needed will vary according to the past management of the soil. In general, it is believed that moderate to small applica-

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tions of amendments at rather frequent intervals are preferable to large applications at long intervals on most of the soils in this group.

GROUP 10

Group 10 includes the hilly and eroded hilly phases of Fullerton fine sandy loam and of Fullerton silt loam; the eroded hilly phase of Decatur silty clay loam; and Bolton loam and its eroded phase. Insofar as management requirements are concerned, the essential differences between these soils and those of group 6 are due chiefly to the stronger slopes of this group, although the Fullerton soils are generally somewhat low in fertility as compared with most of the soils in group 6. These are soils of low to moderate fertility on hilly upland slopes (12 to 25 percent). Most of them are moderately eroded, although the hilly phases of Fullerton soil and Bolton loam are virtually uneroded. Because of the strong slopes and present eroded condition nearly all these soils are easily susceptible to more erosion. The soils are easily maintained in good tilth except for the Decatur soil, but the hilly slopes make the soils at least moderately difficult to work.

These soils are poorly to fairly well suited to crops requiring tillage. Moderately long rotations, including chiefly legumes, legume-grass mixtures, and small grains, are best suited. Row crops can be grown once in 6 years if necessary, but if feasible from the standpoint of good farm management, intertilled crops may well be omitted. Corn followed by a small grain seeded to a lespedeza-grass mixture for hay or pasture to remain 4 to 6 years is a suitable rotation. Alfalfa can be used instead of lespedeza and grass for the forage crop, but it is more exacting in its requirements for amendments. Permanent pastures of grass and legume mixtures will do well under good management. In some sections of Tennessee, peaches, apples, and strawberries produce well on soils similar to those of this group.

All the soils in this group are deficient in lime, phosphorus, nitrogen, and probably potassium. Moderate quantities of lime and phosphorus are needed in all rotations, and probably potash where alfalfa is in the rotation. After these soils have been improved sufficiently to support good stands of legumes, nitrogen may not be needed where legumes make up a large part of the rotation, although small to moderate quantities applied to row crops and small grains in the rotations will likely give increased yields. Barnyard manure is a good source of both nitrogen and potassium for all crops and also serves to increase humus and improve the water retaining properties of the soils. It should be supplemented, however, with phosphate fertilizer to obtain the proper balance of plant nutrients. Increased yields and improved quality of alfalfa can probably be obtained by small applications of boron to many of the soils.

Good tilth is rather easily maintained in most of these soils, and tillage can be accomplished over a fairly wide range of moisture conditions except on the Decatur soil, which has rather exacting tillage requirements. Contour tillage is essential to the good management of the soils in this group, and where feasible strip cropping is a desirable practice, especially on the longer slopes. Terracing is not practicable on the strong slopes. The soil should remain bare of vegetation as little

as possible and winter cover crops are needed on places that would otherwise remain unprotected.

Although these soils can be used under careful management for growing tilled crops, they are probably better suited physically to permanent pastures. Pastures will respond well to moderate applications of lime at relatively short intervals after an initial heavy application. They should also receive moderate to large applications of phosphorus. Application of potash may aid in obtaining a good stand of pasture plants; but after establishment of a good sod, scattering of droppings will likely provide sufficient potassium. A contour seeder is well suited to making the initial seedings and fertilizer applications, but subsequently the only special practice for conserving moisture and soil material ordinarily needed is careful control of grazing during periods of extreme moisture conditions. At these times overgrazing may impair soil tilth and damage the pasture stand to the extent that areas will be left bare of vegetation and subject to sheet and gully erosion. As on soils of other groups, weeds and brush can be controlled by occasional mowings.

GROUP 11

Group 11 includes Atkins fine sandy loam, Guthrie and Melvin silt loams, and Tyler very fine sandy loam. These soils are on bottom lands, terraces, and in depressions. They have nearly level slopes and poor drainage, both on the surface and internally; are relatively low in content of lime, plant nutrients, and organic matter; and are generally strongly acid except for the Melvin soil, which is typically moderately high in natural fertility and only slightly to medium acid.

These soils are poorly suited to crops requiring tillage and may be expected to produce only small yields of most crops, even where they are drained artificially. If they are used for crops, corn and hay are probably best suited to them. Sorghum and soybeans can also be grown on the artificially drained areas. Crops will probably respond to fairly heavy applications of lime, phosphorus, and potash. Nitrogen can be maintained with leguminous hay crops, as alsike clover, or by commercial fertilizer.

Pastures are generally fair to poor, but they can be greatly improved if the soils are drained and limed; fertilized heavily with phosphorus and probably potash on the Atkins, Guthrie, and Tyler soils; and grazed moderately close. Clipping to eradicate weeds and scattering of droppings are other good practices needed by pastures. Where undrained, pastures can be expected to be improved by the practices suggested, but water-tolerant wild grasses, sedges, and other plants would make a large part of the herbage; whereas if the soils are drained, the more desirable tame grasses and legumes would be dominant in the pasture mixture.

GROUP 12

Included in this group are the following soil types, phases and miscellaneous land types: Armuchee silt loam and its steep phase; Armuchee silty clay loam, eroded and eroded steep phases; Colbert silty clay loam, eroded rolling phase; Decatur silty clay loam, severely eroded hilly phase; Hayter stony loam, hill phase, eroded hill, steep, and eroded steep phases; Sequoia shaly silty clay loam, severely eroded phase;

Talbott silty clay loam, eroded hilly and severely eroded hilly phases; Waynesboro very fine sandy loam, eroded hill phase; Rolling stony land (Talbott soil material); Hilly stony land (Talbott soil material); and Hilly stony land (Colbert soil material). These soils have hilly and steep slopes except for the eroded rolling phases of the Colbert and Montevallo soils, the severely eroded phases of the Sequoia and Talbott soils, and the Rolling stony land (Talbott soil material). Most of them are on uplands, but the Hayter soils are on colluvium and the Waynesboro on old high terraces.

Practically all these soils are derived from materials at least partly of limestone origin except the Montevallo soil, which is from acid shale materials. All the soils are moderately to severely eroded except Armuchee silt loam and its steep phase, and the hill and steep phases of Hayter stony loam. Eroded phases of the stony land types are not mapped, but in most places they are eroded to some extent, in fact, some of them may be areas of shallow soil so much eroded that rock outcrop forms a significant part of the land area. All these soils are moderately to strongly acid, but they are for the most part at least moderately fertile as compared with other soils on hilly and steep slopes. Under grass cover most of them absorb and retain moisture fairly well.

All the soils in this group are considered poorly suited to crops requiring tillage because of some one or more of such unfavorable features as strong slope, stoniness, serious erosion and susceptibility to further erosion, strong acidity, and deficiencies in essential plant nutrients and moisture. Most of the soils, however, respond well to a good system of pasture management and can well be used for pasture production.

Most of the native pastures consist largely of broomsedge and other wild grasses, but the liberal use of lime and phosphorus will permit the establishment of good pastures of tame grasses and legumes. In some places potash applications may be necessary also to obtain good sods. but after the stand is established, scattering of droppings will probably furnish sufficient of this essential element. Clipping a few times each season will do much to control weeds and brush and remove excess herbage.

Careful control of grazing is necessary during periods of adverse moisture conditions. During periods of heavy rainfall too much grazing will result in trampling of the pasture plants and puddling of the surface soil so that water runs off and erodes the soil rather than being absorbed. Too close grazing in the drier summer months will also result in damage to the pasture stand, thereby denuding the soil and exposing it to erosion by subsequent rains.

Initial seedings of pasture and fertilizer applications can well be made with a contour seeder. Otherwise, on well-managed pastures, practices for conserving soil material and moisture are not ordinarily needed; although stabilization of gullies by suitable structures may be essential to establishing and maintaining good pastures on many of the soils. Thin shading by widely spaced walnut and black locust trees is beneficial to many of the pastures.

In places the need for land may make necessary the use of some of the soils for cropland, even though they are not well suited physically to such use. Where so used. extremely careful management is needed to avoid serious depletion of the soils. Long rotations consisting largely

of close-growing hay and small-grain crops are best suited to the soils. A 7- to 10-year rotation, including 1 year of an intertilled crop followed by small grain seeded to a legume or legume-grass mixture can be used, or small grain for a year followed by several years of hay or pasture is a good cropping system.

Lime and phosphorus in moderate to large quantities at moderately long intervals are essential to the production of legumes and the better types of grasses. If small to moderate quantities of potash are applied to the row crop and the small grain, sufficient residual effect will be obtained to supply the requirements of the sod crop on most soils. Barnyard manure is a good source of both nitrogen and potassium and also helps to improve the physical properties of the soil by increasing the humus.

Wherever feasible, all tillage operations should be on the contour. Terracing is not practicable on these hilly and steep, comparatively shallow soils, but on the longer slopes a system of strip cropping may be a useful means of conserving water and soil material. Gullies can be stabilized by the use of check dams or other structures and by use of vegetation.

GROUP 13

Group 13 includes Bolton silty clay loam, severely eroded phase; Bolton loam, steep and eroded steep phases; Clarksville fine sandy loam, eroded hilly phase; Clarksville cherty fine sandy loam, hilly and eroded hilly phases; Clarksville cherty silt loam, hilly and eroded hilly phases; Fullerton cherty fine sandy loam, hilly and eroded hilly phases; Fullerton cherty clay loam, severely eroded phase; Fullerton fine sandy loam, severely eroded hilly phase; Fullerton cherty silt loam, hilly, and eroded hilly phases; and Montevallo shaly silt loam, eroded rolling phase. These are coarse- to medium-textured soils of moderately low to low fertility on hilly and steep slopes. All are on uplands and are derived from parent material weathered chiefly from cherty dolomite or dolomitic limestone, except the Holston, which is derived from old stream alluvium on old relatively high terraces. Most of them are moderately to severely eroded except Bolton loam, steep phase, and the hilly phases of Clarksville and Fullerton cherty silt and fine sandy loams that are in forest and are virtually uneroded. All these soils are low in lime, organic matter, and mineral plant nutrients, although the Bolton are somewhat more favorable in these respects than the others. Most of them are somewhat droughty because of the rapid loss of water through runoff on the strong slopes and the rather open porous nature of the soils themselves.

Because of their unfavorable physical properties, these soils are not considered suited to crops requiring tillage, but under a good system of management they produce satisfactory pastures. The present pastures on most of these soils consist largely of broomsedge and other native grasses and weeds, but by liberal applications of lime and phosphorus good stands of legumes and tame grasses can be obtained. Many areas are also deficient in potassium, and potash fertilizers also will be required by the legumes with more exacting nutrient requirements; although after sods are established, the scattering of droppings may insure enough of this element.

Small applications at rather frequent intervals of all amendments on these soils is preferable to infrequent large applications. Careful control of grazing during periods of adverse moisture conditions is especially important. Careful grazing and the use of adequate amendments are effective in controlling weeds, but occasional mowings may be necessary to remove undesirable herbage and keep down brush. The lack of readily available water supplies for stock may limit the usefulness of many areas for pasture.

Although these soils are poorly suited to growing tilled crops, the need for cropland may require their use for this purpose in some places. When so used, management practices for supplying lime, phosphorus, and potassium; maintaining or increasing nitrogen and humus; and conserving soil moisture and soil material are needed to maintain productivity.

SOIL ASSOCIATIONS

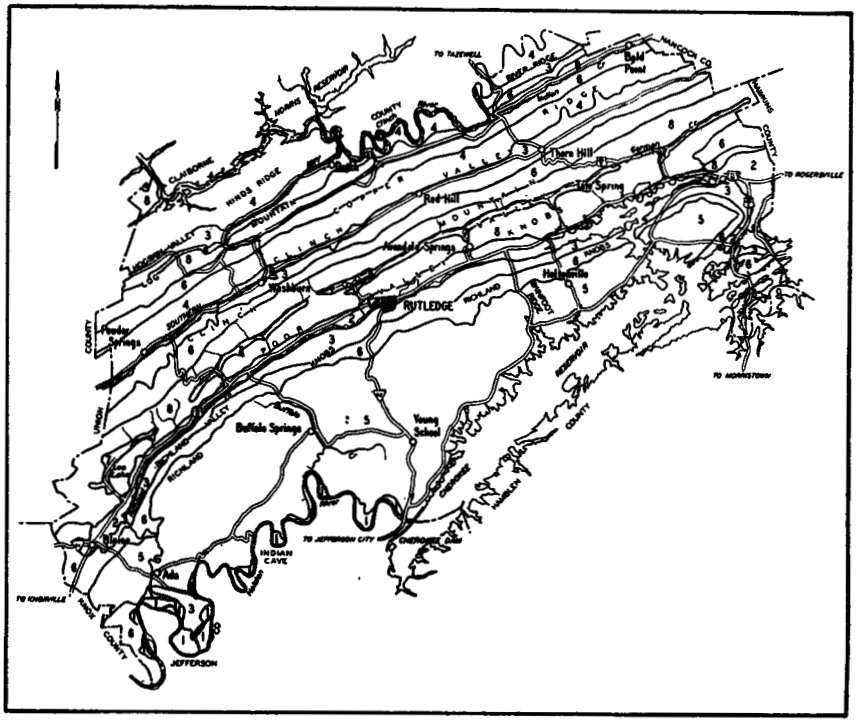

FIGURE 2.—Aereal extent and geographic distribution of associations of physical land classes in Grainger County, Tenn.

1. Waynesboro-Holston-Bruno.
2. Decatur-Talbott-Sequoia.
3. Stony land (Talbott and Colbert materials).
4. Fullerton-Clarksville-Bolton.
5. Sandy Fullerton-sandy Clarksville-Bolton.
6. Armuchee-stony land (Talbott and Colbert materials).
7. Muskingum-Jefferson-Philo.
8. Muskingum-rough stony land (Muskingum material).

A soil association may be considered a group of soils occurring together in a characteristic pattern; it may also be considered a landscape definable as to the kind, proportion, and distribution of its component soils. In either case it may consist of only a few or of many soils, all of which may be either similar or representatives of differing types. In all soil associations, however, there is a certain uniformity of soil pattern.

The uses of soil association maps differ from those of detailed soil maps. For example, their scale does not allow sufficient information for the study of individual farms or for the planning of farm operations. Like other simplified or generalized soil maps they serve especially to give a picture of the soil resources of a larger area, as a community, a county, a State, or a valley region. Soil association maps should be useful in regional studies of agricultural production or of the management adjustments that may be necessary in such production.

The eight soil associations designated in figure 2 are as follows: 1, Soils developed on first bottoms and stream terraces; 2, 4, and 5, soils of the upland developed over limestone, a considerable acreage of which is suitable for crops requiring tillage; 3 and 6, soils of the upland developed over limestone, too stony for tillage; and 7 and 8, soils of the upland and associated colluvium over sandstone.

1. WAYNESBORO-HOLSTON-BRUNO ASSOCIATION

All the areas of the Waynesboro-Holston-Bruno association are adjacent to the Holston River. This group consists of soils developed on first bottoms and associated stream terraces, and the principal series represented are the Waynesboro, Holston, Bruno, and Sequatchie, with less extensive areas of Lindside and Huntington, and small included areas of soils of the upland. In general the relief is smooth, the slope ranging from nearly level to rolling, occasional narrow strips having a slope of 12 to 30 percent. The soils are moderately productive, workability is good, and conservability is fair to very good. Second- and Third-class soils predominate, with limited areas of First- and Fourth-class soils intermingled. A large part of this association is used for crops, chiefly corn, small grains, hay, and tobacco. The rest is used for pasture.

2. DECATUR-TALBOTT-SEQUOIA ASSOCIATION

The Decatur-Talbott-Sequoia association occupies parts of Richland and Clinch Valleys, which are of limestone. It consists of a relatively intricate pattern of (1) soils developed over high-grade limestone, chiefly Decatur, Dewey, and Talbott; (2) soils developed over interbedded limestone and shale, chiefly Sequoia; (3) soils developed from acid shale, Montevallo; and (4) soils developed on alluvium and colluvium, chiefly Emory, Hayter, Leadvale, and Lindside.

Areas of this association have an undulating to strongly rolling surface, with occasional small areas having a slope of more than 12 percent. A few areas are too stony for tillage. The suitability of the soils for agriculture ranges widely. First-, Second-, and Third-class soils predominate, with smaller acreages of Fourth- and Fifth-class soils intermingled. The First-class soils are very productive, easily worked and conserved, and are suited to relatively intensive use; the Second- and

Third-class soils in general are lower in productivity and their conservability is only fair because of the difficulty of controlling runoff. The workability of the Second- and Third-class soils varies greatly according to the slope and degree of erosion.

A large part of this association is cleared and used for corn, small grains, hay, tobacco, and pasture. Yields are relatively good, and a large part is well suited to pasture and hay legumes and grasses.

3. STONY LAND (TALBOTT AND COLBERT MATERIALS) ASSOCIATION

The stony land (Talbott and Colbert materials) association lies in three relatively long narrow strips in limestone valleys that cross the county from northeast to southwest. It consists chiefly of land types too stony to be tilled, although there are included significant though limited areas of Talbott, Colbert, and Lindside soils suited to crops requiring tillage. The surface is chiefly undulating to hilly, with large parts having a slope of about 12 percent. Much of the group consists of Fourth-class soils with a limited acreage of the Second- and Third-class intermingled. In general the association is not well suited to crops but is well suited to good quality grazing, especially where lime and phosphorus are applied.

4. FULLERTON-CLARKSVILLE-BOLTON ASSOCIATION

The Fullerton-Clarksville-Bolton association occupies the cherty ridges in the northwest half of the county. Developed over dolomitic limestone, the soils are predominantly of the Fullerton and Clarksville series, with a moderate acreage of Bolton and Greendale soils intermingled. In general the surface is that of a broadly rounded ridge land, the slope ranging from rolling to hilly and steep, though much of the landscape has a slope of 12 to 45 percent. The soils have moderate to low fertility, and a great part of the acreage is moderately cherty. All of the soils are relatively deep to bedrock. Fourth- and Fifth-class soils predominate, and the Second- and Third-class occupy approximately a fifth of the area.

About two-thirds of this association has been cleared and is being used for general farm crops and unimproved pasture or is idle. The remaining steep part is in forest. Corn, small grains, certain hay crops, and tobacco are the chief crops. Inasmuch as the soils are of low fertility and are rolling to steep, they require a high level of management if they are to be maintained in a productive state. They are suited to general farming, with moderately long rotations on the soils suited for tillage and permanent pasture on the Fourth-class soils. These soils are not so well suited to pasture legumes and grasses as are those of the first three associations.

5. SANDY FULLERTON-SANDY CLARKSVILLE-BOLTON ASSOCIATION

The sandy Fullerton-sandy Clarksville-Bolton association occupies a broad belt comprising a large part of the southeastern half of the county. The soils are developed over dolomitic limestone in which are sandy or arenaceous layers of dolomitic limestone. In several respects this association is similar to the Fullerton-Clarksville-Bolton association, but differs chiefly in having a notable content of sand. The surface is that of a broadly rolling ridge land, the slope ranging from rolling to hilly

and steep (12 to 45 percent) (pl. 8). The soils are of low to moderate fertility, and a large part of them is cherty. All are relatively deep to bedrock. Fourth- and Fifth-class soils predominate, but Second- and Third-class soils occupy more than a third of the area. About three-fourths has been cleared and is used for crops or unimproved pasture. The remainder, chiefly on the steepest areas, is in forest.

Corn, small grains, certain hay crops, and tobacco are the chief crops grown. Inasmuch as the soils are of low fertility and are rolling to steep, they require a high level of management if they are to be maintained in a productive state. They are suited to general farming, with a fairly long rotation on the soils suitable for tillage and permanent pasture on the extensive acreage of Fourth-class soils. These soils are less well suited to pasture legumes and grasses than are those of the first three associations.

6. ARMUCHEE-STONY LAND (TALBOTT AND COLBERT MATERIALS) ASSOCIATION

The Armuchee-stony land (Talbott and Colbert materials) association occupies three belts that extend across the county from northeast to southwest. They consist chiefly of stony land types and soils that are very shallow to bedrock limestone and shale. These belts are steeply sloping and their surface drainage is to the northwest. Because of strong slope, stoniness, and shallow depth to bedrock very little of this association is suitable for tillage. The less steep and less stony areas, which represent more than 50 percent of the acreage, are well suited to permanent pasture. A considerable part of the land is cleared and used for this purpose, and the rest is in cut-over hardwood forest.

7. MUSKINGUM-JEFFERSON-PHILO ASSOCIATION

The Muskingum-Jefferson-Philo association occupies the irregular valley between Clinch Mountain and Poor Valley Ridge. It consists of soils on colluvium and alluvium washed from the adjacent areas of Muskingum soils and includes limited areas of the less steep Muskingum soils on the lower slopes of the two ridges. The surface ranges from nearly level on the narrow strips of Philo soils along the creeks to hilly on the Jefferson and Muskingum. Probably half the acreage is cleared for general subsistence crops and unimproved pasture. The fertility is low and the yields are small.

8. MUSKINGUM-ROUGH STONY LAND (MUSKINGUM MATERIAL) ASSOCIATION

The principal areas of the Muskingum-rough stony land (Muskingum material) association occupy Poor Valley Ridge, Log Mountain, and a large part of Clinch Mountain. Much of the northwest slope of Clinch Mountain is in the Armuchee-stony land (Talbott and Colbert material) association. That part of the association on Poor Valley Ridge is over acid shale and fine-grained sandstone; that on Log Mountain is over interbedded acid shale and fine-grained sandstone, a considerable part of which is somewhat purple; and that on Clinch Mountain is over coarser grained sandstone. A large part of this association consists of soils very shallow to bedrock; and stony land types, consisting of sandstone material. The surface is steep and very little acreage is suitable

either for crops or for pasture because of the very low productivity and the impracticability of carrying on field operations. Much of the acreage is under deciduous cut-over forest, to which it is best suited.

WATER CONTROL ON THE LAND

Water control on the land consists of practices having to do with the regulation of runoff and with the maintenance of soil-moisture conditions favorable for the growth of a particular crop or group of crops. These practices include (1) protection from floods, (2) artificial drainage, (3) irrigation, and (4) control of runoff.

Little has been done to protect areas from floods, except that Cherokee Reservoir now makes the bottom lands along the Holston River below the dam immune from overflow. Considerable damage is done occasionally by overflow of streams throughout the rest of the county. Most floods occur early in spring, before crops are on the land, and flooding is not so serious a problem as on areas farther from the source of the streams.

Artificial drainage of some areas of poorly drained soils has been accomplished by ditching, but drainage is not a serious problem on most farms. Little tiling has been done.

Little irrigation is done at present, although it doubtless would increase crop production on many soils in dry seasons. Its use to supplement rainfall might prove economically feasible under some conditions, especially on gardens and on truck crops and other crops of high value.

Maintaining favorable soil-moisture conditions for plants and controlling runoff are the problems of major importance in the control of water on the land. Many soils are capable of improvement as regards increased absorption and retention of moisture and many are of such nature as to cause more rapid runoff than is desirable.

There may be two direct undesirable results from runoff: (1) Loss of water that could have been useful to plants, and (2) loss of soil. Loss of water always results; loss of soil material may or may not accompany it. Of the two, the loss of soil material is the most apparent because it leaves an eroded condition and its effects are generally cumulative. It is not a thing to be corrected by itself, however, because the loss of useful water and loss of soil material are intimately associated in their causes, in their effects one on the other, and in the practices designed for their control. The conservation of both is based on the proper control of the water on the land.

In the area of the Tennessee Valley, of which Grainger County is a part, a series of dams has been constructed to control and use the water in the streams for social betterment. These dams make navigation possible on the waterways, decrease floods by regulating the volume of flow, and provide a head of water for the production of electric energy. Their effectiveness is dependent to a large extent on their ability to regulate the volume of flow of the large streams. Most of the streams are feeders on the main river system, and any measures that regulate the flow of water from the land they drain increase the effectiveness of the entire system of dams. Moreover, the principal means of controlling floods on these feeder streams is through holding the water on the land where it falls.

Water is a natural resource to be exploited, both on the land and in the streams. It is necessary for the growth of plants, and even in a region of high rainfall, as in Grainger County, lack of water is commonly a limiting factor in the growth of plants during certain periods of the year. Any measures that result in a more nearly adequate and even supply of water during the growing season will promote increased production of the plants on which the people on the land depend for their livelihood.

The effective use of water by plants is conditioned on other factors that may limit crop production, and commonly one of the major limiting factors in this county is the supply of mineral plant nutrients. If the water that falls on the land is to be used most effectively by plants, it must remain in the soil in quantities sufficient for their needs, an adequate supply of plant nutrients must be available, the physical condition of the soil must be suitable for the root systems, and insects, diseases, and pests must be controlled.

Runoff is retarded by vegetation in proportion to the density of the cover and the tendency of the vegetation to induce a soil condition that favors the absorption and retention of water. In addition, the vegetative cover, its root system, and its debris decreases the loss of soil material in the runoff that does occur, by reducing the rate of runoff and by binding the soil particles. Forests are very effective in this respect; sod-forming plants, as hay and pasture grasses and legumes, also are effective; small grains and other close-growing crops are somewhat less effective; and intertilled crops are generally least effective.

Several soil characteristics have a direct bearing on the problem of runoff control. Of these, slope is of outstanding importance. Other characteristics being similar, steep-sloping soils are the most susceptible to damage by runoff and have the most restricted suitability for agricultural use, whereas those that have a smooth or nearly level surface are the least susceptible to such damage and in general have the greatest range in suitability for agricultural use. Other soil characteristics having an important bearing on the problem of runoff control are consistence, texture, and depth to bedrock. In general, land use and crop rotations should be adjusted as to protect the soils against runoff hazards.

To be most effective, the vegetative cover on crop and pasture land should be vigorous in growth. Useful management practices to this end are suitable applications of lime, manure, and fertilizers and the use of legumes in the rotation. Agricultural lime supplies the plant nutrient calcium and adjusts the acidity of the soils. Manure supplies nitrogen, potash, and organic matter and aids in maintaining a good physical condition of the soil. Mineral fertilizers supply nitrogen, phosphorus, and potash and may be used to supply minor nutrient elements. Legumes, if properly inoculated, extract nitrogen from the air, and their root systems add organic matter and aid in maintaining good soil conditions.

These practices promote vigorous growth of crops in the rotation, which is desirable not only from the standpoint of control of runoff but also of effective use of soil water for crop production.

The soil should be so tilled as to be left in a condition that will retard runoff and favor absorption of water, and at such times and in such manner as to leave it bare of vegetation as little of the time as possible.

Contour tillage is desirable on many slopes to retard the rate of runoff. Contour strip cropping may be desirable on the steeper slopes, and it is generally most feasible and most desirable on long slopes.

Engineering methods of water control, as terracing, are commonly expensive. Terracing leaves many soils in such condition that they can be restored to high productivity only after considerable effort. Terraces also require maintenance. Such practices have a place in water control under certain conditions, but they are generally to be resorted to only where runoff cannot be controlled by other methods, which consist essentially of good soil management for good production.

As in all other forms of land management, the best method for the control of water depends not on the soil alone but on the particular conditions that exist within the farm unit. Each farmer should choose that particular combination of practices that fulfills the requirements of his farm unit and provides the maximum of water control that is feasible. Moreover, he should choose practices that provide not only the maximum water control but also the proper medium for the growth of plants and the plant nutrients necessary for efficient use of the water thus conserved. Effective control of water is obtained on many farms and can be obtained on many more by the use of soil management practices that would ordinarily be considered sound from the standpoint of efficient production.

The control of water is thus not an isolated problem. It involves all the practices of good soil management that would ordinarily be employed and is a part of successful crop production. It can be accomplished largely through good farming practices, including the proper choice and rotation of crops, proper fertilization and tillage, the control of insects, pests, and diseases, and, in some places, application of engineering methods.

FORESTS [10]

The first settlers found Grainger County an unbroken forest, a common hunting and fighting ground of the Indians and abounding in elk, buffalo, bear, deer, turkeys, and other game and many kinds of fur and other small animals. There were no sawmills in the early nineteenth century and most of the building material was hewn logs and puncheon floors. Logrolling and house raising were community festivities. A log schoolhouse might have a huge fireplace across almost one entire side of the building, backless benches of rude hewn poplar slabs through which holes had been bored for the legs, and no desks. At a later period logs were rafted down the rivers to Knoxville and other places where lumber manufacturing facilities had been established.

An income of $23,772 was received by the 133 farms reporting forest products sold in 1939. Based on the number of farms reporting woodland in 1939, the average size of farm woodland is 28 acres. Approximately 46 percent of the land area of the county is in forest (*11*), of which 56 percent is farm woodland, 38 percent private nonfarm forest, and 6 percent public forest adjoining the Clinch River. A great part of the soils suitable for crops has been cleared. In fact, there is evidence

[10] Prepared by G. B. Shivery, extension forester, University of Tennessee.

of land being recleared a second time after abandonment following the initial clearing.

Of the timber producing areas 36 percent is upland hardwoods (*10*), 7 percent oak-chestnut, 53 percent yellow pine-hardwoods, and 4 percent cedar hardwoods. As a further indication of the size and stage of development of the timber resources of the county, 17 percent of the total area in forest is classified as saw timber, 76 percent as cordwood, and 7 percent as below cordwood.

Although Clinch Mountain proper and Poor Valley Ridge are definitely in yellow pine-hardwoods, there is no exact correlation between soil association and broad forest type. This forest type likewise extends roughly east and west of Highway 32 to the Holston River. It also occupies the northeastern segment of the sandy Fullerton, sandy Clarksville, and Bolton soils as well as the Skinfoot Ridge cut off by the Cherokee Reservoir. Otherwise the prevailing forest type is upland hardwood so that these two types merge one into the other. Oak-chestnut occurs on Hinds Ridge and on Log Mountain, interspersed in general with upland hardwoods, which in turn are associated with yellow pine-hardwoods. Cedar-hardwoods are found on Talbott and Colbert stony land.

Fullerton soil types—cherty silt loam, steep phase; cherty silt loam, eroded steep phase; and cherty silty clay loam, severely eroded steep phase—on Hinds and Copper Ridges of the Fullerton-Clarksville-Bolton association are either now in forest or to a very large extent abandoned to forest following the original clearing. A similar condition holds for Fullerton cherty fine sandy loam, hilly phase, and Fullerton cherty clay loam, severely eroded hilly phase, south of Richland Knobs. Species characteristic of upland hardwoods—black, southern red, scarlet, post, and northern red oaks, pignut and white hickories, yellow-poplar, black tupelo, basswood, and dogwood—predominate, along with varying percentages of shortleaf and Virginia pines. The eroded condition of Clarksville cherty silt loam, eroded hilly phase, on Hinds and Copper Ridges resulted from lack of proper management following the original clearing of the oak, hickory, poplar, sourwood, and occasional pines of the upland hardwoods. Clarksville cherty silt loam, steep phase, practically all of which is in forest, illustrates the proper land use in contrast with Clarksville cherty silt loam, eroded steep phase, cleared and row-cropped. The deciduous forest is likewise present on Clarksville cherty fine sandy loam, hilly phase, and absent on the eroded hilly phase, all of which has been cleared and much of it again abandoned to forest and unimproved pasture.

Clarksville cherty clay loam, severely eroded hilly phase, largely in the Skinfoot Ridge, occasionally contains gullies 2 to 4 feet deep. The Bolton soils where undamaged by erosion support a growth of better quality timber, as well as a more valuable composition than exists on types of Clarksville classified as Fifth-class soils. Rough stony land (Talbott soil material) is wooded for the most part, dominantly with deciduous types, including yellow locust, redcedar, and yellow-poplar. Such land types as Hilly stony land (Colbert soil material) and Limestone outcrop, of low yield even in forest, support primarily a growth of redcedar as the best species.

The steep and very steep phases of Armuchee silt loam are forested

and classified as upland hardwoods, while the shaly silty clay loam, severely eroded steep phase, represents areas of these soils that have been cleared and are mostly abandoned to forest and unimproved pasture. The primary use classification of the Muskingum soils and of Rough stony land (Muskingum material) is forest, since the soils are adapted neither to crops nor to pasture. All phases and land types of Muskingum, including Rough stony land (Muskingum soil material), Sandstone outcrop, and Hector stony fine sandy loam on Clinch Mountain and Poor Valley Ridge, should be managed as forest. Likewise the Lehew soils, mostly on Log and Lone Mountains, should be managed as forest as well as most of the Montevallo soils.

The number of sawmills operating in 1909 was 23 (*5, 9*), in 1912, 12, and in 1942, 32, of which 2 were idle that year. In 1939 the production of lumber amounted to 2,900 M [11] board feet of pine and 3,235 M board feet of hardwood, while in 1942 production was 2,600 M and 2,733 M, respectively. The production of pine pulpwood in 1941 was 1,400 cords; hardwood pulpwood, 900 cords; and chestnut extract wood used for pulp, 5,200 cords.

In 1940 saw timber volume at the beginning of the year was 5,085,000 M board feet, drain for the year 214,000 M board feet, and growth 55,000 M board feet, ending the year with an inventory of 4,925,000 M board feet. Cordwood volume was 12,820,000 cords; drain, 574,000 cords; and growth, 987,000 cords; with a final figure of 13,233,000 cords of small-sized material. Even though cordwood shows an increase it should be remembered that more than half the trees will be crooked, defective, or otherwise unsuited for potential saw timber, but instead should be used as pulpwood, chemical wood, fuelwood, posts, and similar purposes.

The area under organized fire protection in the county is 79,360 acres, radiating from the forest-fire tower on Clinch Mountain north of Avondale Springs. The 5-year record, 1939-43, shows a total of 71 fires, 19 caused by brush burning and 15 incendiary, the 2 principal causes. The total area burned over was 4,731 acres, or an average of 66 acres per fire. Fire control is necessary to satisfactory forest production and to maintenance of maximum soil porosity and erosion control. Control of grazing is necessary for similar reasons. The timber-producing capacity is gradually destroyed by repeated browsing and final curtailment of tree reproduction so that natural regeneration of the stand is prevented. Compaction of the soil, disturbance of humus, and resulting interference with soil porosity lessen water absorption.

The progressive deterioration of the forest resource must be halted. A much greater value must be placed on the potential crop of saw-timber trees. The cut-over woodland and forest contain much cull timber, which hinders the development of these potential crop trees. Farm woodlands can be materially improved by using such inferior trees for fuel and other minor farm needs. They should be cut for pulpwood or chemical wood, reserving the vigorous individuals with developed crowns to grow into more valuable products. Such improvement resolves itself into systematic cutting and use of crooked trees, short bushy-topped ones, unsound culls, and slow-growers, reserving the

[11] Data from Department of Forestry Relations, Tennessee Valley Authority.

straight, tall, well-crowned individuals, free from defect, for growth into final crop timber.

Second-growth stands on eroded and once cleared and cultivated land are composed largely of shortleaf pine; in the mixture is Virginia pine, a more prolific producer of seed and one utilizing drier and less favorable sites. Shortleaf pine seeded by natural means displays a remarkable ability to establish itself on situations where the mineral soil is exposed, provided seed trees are present and so spaced that proper seed dissemination can be effected by the wind at the time the cones open early in fall. Stands to increase the rate of growth of this kind can be improved by judicious thinning when the trees are small and the risk from southern pine beetle damage is decreased. Erosion in such thickets is checked, and the process of litter and humus accumulation begins to rebuild the soil.

Occasions arise when it is necessary to resort to forest-tree planting, particularly on the Fourth- and Fifth-class soils that are severely eroded. Every particular situation presents a specific problem to be solved. The technique of tree planting to insure success includes certain essential advance preparation, which is agreed on with the landowner at the time a preliminary examination of the area is made. This preparation includes breaking and mulching galled areas, building simple low-brush check dams in gullies, and plowing contour furrows. During the period 1936–41 a total of 101 projects involving 536 acres was reclaimed with seedling stock of black locust and shortleaf pine.

It is of first importance as a part of the preliminary examination of any area that pioneer species be selected that suit the characteristics of the particular soil, including degree of erosion, exposure, and other local features. Although farmers many times specify locust, because of their farm needs for fence posts, pine, usually shortleaf, is better adapted to the severe growing conditions encountered on lands designated for use as forest. Black locust does well in gullies in the moist well-aerated soil material accumulated behind simply constructed check dams; it follows therefore that a large proportion of areas need black locust for the silting basins in the gully bottoms and shortleaf pine for the eroded strips and between the gullies. Heavy dependence, therefore, must be placed on shortleaf pine on most of the eroded lands except where intensive land preparation and fertilization with phosphate warrant the use of black locust.

Shortleaf pine should be the principal species, with black locust an alternate under certain favorable conditions of preparation and exposure, for use on Bolton silty clay loam, severely eroded steep phase, and the eroded phases of Fullerton and Clarksville soils. Rough gullied land (limestone residuum) is primarily a land-reclamation problem in connection with which black locust is a valuable ally along with pines and other selected species present on similar adjoining areas. Still more dependence must be placed on pine on the eroded members of the Armuchee series. On Rough gullied land (shale and sandstone residuum), shortleaf pine should be used wherever conditions permit. Where the site is particularly difficult for establishing a forest cover, Virginia pine should be used. It should be emphasized in every instance that conditions of site should be the deciding factor in the selec-

tion of species, because production of trees not adapted to a situation will be unsuccessful.

Forest has important indirect benefits aside from the production of wood products, especially on areas of land subject to erosion. A protective layer of forest litter absorbs the impact of the falling drops of water, preserving the tiny pores and channels between the soil particles as the water makes its way downward. Fungi, bacteria, and tiny animals that consume the litter and each other result in a dark-brown colloidal substance called humus, which when carried downward into the mineral soil by percolating water improves both physical structure and fertility. This litter and humus has in addition great ability to absorb water directly. Porosity is further achieved by the channels left after the decay of dead roots. Highly beneficial also is the soil-binding function of the surface roots, the densest network of which is found in the lower parts of well-developed litter layers. Where the forest cover is properly maintained, second-growth forested soil does not lose its porosity unless overgrazed or the litter is destroyed by fire.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the parent material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of development have acted on the material. The climate, and its influence on the soil and plants, depends not only on temperature, rainfall, and humidity but also on the physical characteristics of the soil or soil material and on the relief, which in turn strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

The climate of the county is of the humid, warm, continental type, with a mean annual precipitation of 44.54 inches, a mean summer temperature of 74.3° F., and a mean annual temperature of 57°. Having developed in such a climate, the mature soils are highly leached, are low in organic matter, and have well-developed podzolic features. The climate, however, is practically uniform over the entire county; and, owing to this uniformity, differences in soils within the county cannot be explained on the basis of broad differences in climate.

The forces of climate alone cannot bring about the development of soils. Operating alone they can only produce the parent material from which the soils themselves are developed. Without living organisms all soils would remain undeveloped and all would be azonal; they would be merely residual or transported products of rock weathering, and the action of living organisms therefore is necessary for development to take place. Of the living organisms influencing soil development, plants and micro-organisms are the ones of primary importance. The general type of vegetation is, to a large extent, controlled by climate; and in this way, climate exerts a powerful indirect effect. A well-developed

soil is the result of the concomitant attack of both climate and vegetation upon the parent material. Where the variation in vegetation has been significant, the morphology of the soil would be expected to vary accordingly. In Grainger County, however, the same general type of vegetation occurred on all the well-developed, well-drained soils. Although there were quite likely differences in the density of the stands and the relative proportions of each species, chiefly hardwoods prevailed over the entire area. Because no great differences in vegetation existed on the well-developed, well-drained soils, differences in the soils ordinarily cannot be attributed to differences in vegetation.

By direct and indirect effects, climate tends to produce similar soils from different kinds of parent material; and if it were not for the inhibiting factors of parent material itself, of relief, drainage, and, in some places, of vegetation, the same kind of soil would prevail over the entire area. Although such a uniform soil obviously does not exist, some general descriptive statements apply to all well-developed, well-drained soils of the region. Under forest vegetation, they all have a dark A_1 horizon, and most of them have an A_2 horizon that is lighter in color than either the A_1 or the B; the B horizon is generally uniformly colored yellow or red, and is finer textured than the A_1 or A_2 horizons; and the C horizon is generally fine textured and variegated with red, brown, yellow, gray, and olive.

According to some recent analyses of a number of soils of Jefferson County, which bounds Grainger County on the southeast, the silica content decreases and the alumina and iron oxide contents increase with depth. The content of organic matter is moderate in the A_1 horizon, less in the A_2 horizon, and very low in the B and C horizons. All the soils are low in bases, particularly calcium and magnesium; they are also low in phosphorus. Several soils of the limestone valley section of Jefferson County and presumably also of Grainger County, are high in manganese, particularly in the A_1 and A_2 horizons.. The manganese content is highest in the surface layer and decreases with depth. In general, the ignition loss is relatively low indicating that the bound water content is not high. These soils are medium, strongly, or very strongly acid in reaction. In general, the quantity of silt decreases with depth, whereas that of clay increases from the A_1 horizon through the C; and the colloid content is low in the A horizon, much higher in the B, and highest in the C. All the soils with the above characteristics are considered zonal soils.

Grainger County lies in the northern part of the zone of Red and Yellow Podzolic soils, near the southern boundary of the Gray-Brown Podzolic soils (*12*). The well-developed, well-drained soils of this county are generally considered as members of either the Red Podzolic group or the Yellow Podzolic group, but some of them are morphologically similar to some of the soils mapped in the southern part of the zone of Gray-Brown Podzolic soils, but the red and yellow colors are generally somewhat more prominent and the brown color less prominent.

Throughout the entire county, a striking and consistent correlation exists between the soil and the kind of underlying parent rock material. The present relief has also been greatly influenced by the kind of consolidated rocks, which differ in rate of weathering and content of insoluble minerals, especially silica. Thus not only the soils, but also

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the type of relief is closely associated with the type of consolidated rock. To illustrate, the extensive areas underlain by fairly high-grade limestone or dolomite are generally undulating to gently rolling; extensive areas underlain by highly siliceous limestone and dolomite are generally strongly rolling or hilly; and extensive areas underlain by shale and sandstone are generally hilly or steep. Therefore, by exerting both direct and indirect effects, the character of the consolidated rocks that give rise to the parent material of these soils is the main factor in bringing about the development of different types of soils in the county.

The general character of the rocks underlying the soils of different series is shown in table 6, and by referring to the column headed "dominant relief", the general character of the relief of areas underlain by the various rocks can be deduced. The following tabulation gives the general correlation of the soil series of the uplands with the geologic formations according to the classification of the rocks contained in the Morristown folio (*13*).

Soil series:	*Geologic formations* [1]
Muskingum	Grainger shale and Clinch sandstone.
Armuchee	Sevier shale.
Stony land types [2], Colbert, Talbott	Chickamauga limestone.
Clarksville, Fullerton, Bolton	Knox dolomite.
Armuchee, Sequoia	Nolichucky shale.
Stony land types [2], Decatur, Dewey, Talbott	Maryville limestone.
Montevallo	Rogersville shale.
Decatur, Dewey, Sequoia	Rutledge limestone.
Lehew	Rome formation.

[1] Formations are in descending order according to age, the youngest first.
[2] Miscellaneous land types are characterized by limestone outcrops.

In the humid region, soils occurring in broad depressions or level or nearly level areas are generally poorly or imperfectly drained. In many areas, including a part of this county, however, where the underlying rocks are limestone or dolomite, the subterranean drainage is good and the usual relation of drainage condition to relief is not manifest. This good subterranean drainage is probably due to the marked dip that the rock strata have and the numerous subterranean caverns and crevices. Where underlain by limestone that has a marked dip, the internal drainage is apparently just as good on nearly level areas as on hilly areas. This excellent subterranean drainage on all slopes reduces the influence of relief on the formation of soils and allows the consolidated rocks to dominate the other factors in determining the local soil differences. In other words, the different responses of the different

rocks to the forces of climate and vegetation are responsible for the main local differences in well-developed and well-drained soils in the county.

In Grainger County, limestone and dolomite give rise to parent material that in turn gives rise to the soils of the Colbert, Talbott, Decatur, Dewey, Fullerton, Clarksville, and Bolton series. In going from Decatur to Dewey to Fullerton to Clarksville, the color of the surface soil changes from a dark reddish brown to a light gray and the subsoil from a dark red to yellow. Generally speaking, the quantity of chert in the solum varies in the same sequence—the Decatur having least and the Clarksville most, and, in a general way, the dominant relief of these soils varies in the same sequence—the Decatur having the mildest and the Clarksville the strongest. However, the range in relief for each series overlaps considerably the relief range of adjoining series in this association. The Talbott and Colbert soils also belong in this chain; they differ from the Decatur soils, however, in a different direction. In going from Decatur to Talbott to Colbert the solum is much shallower, and the subsoil is more plastic and sticky. The Bolton soils are similar to the Dewey in color, but their B horizons are more friable and their texture not so fine. Their relief is similar to those of the Fullerton and Clarksville series.

As the surface geology of this region consists of very old formations that were faulted and folded a long time ago, it is fairly safe to assume that the present relief is a product of natural geologic weathering and erosion. Supporting this assumption is the fact that mountaintops are capped with the most resistant rocks and the valley floors are underlain by the least resistant rocks (*2*). In general, the mountains are capped with sandstone, conglomerate, and quartzite, and the valley floors are underlain by limestone or dolomite. Shale gives rise to ridges or plains intermediate in altitude between the mountaintops and the valley floors.

As an example, the valley through which U. S. Highway No. 11W travels is underlain by limestone. Just north of this valley is the Poor Valley Ridge, which rises about 500 feet above the valley and is underlain by shale thinly interbedded with sandstone. North of this ridge is Clinch Mountain, which rises about 900 feet above the ridge and is underlain by sandstone. Just north of this mountain is a valley underlain by limestone, which is about 1,200 feet below the mountain. Just north of this valley is a ridge that rises about 400 feet above the valley and is underlain by cherty dolomite. Although this relation is not everywhere present, it is evident in so many places in the Great Valley of East Tennessee that it may be considered normal.

On the assumption that this whole section was a peneplain before the present relief was formed, then it follows that the limestone underlying the Colbert and Talbott soils was the most soluble and most easily weathered of all the limestone and dolomite in Grainger County. Because the covering at present is less over the rock underlying these soils than it is over the rocks underlying the Decatur, Dewey, Fullerton, Clarksville, and Bolton, it is reasonable to assume that the limestone underlying the Colbert and Talbott had the lowest concentrations of insoluble material, especially silica. Although the rock floor is uneven and rough, the average depth to bedrock probably increases going from

Colbert, to Talbott, to Decatur, to Dewey, to Fullerton, to Clarksville, to Bolton. This indicates that the content of insoluble impurities of the underlying limestone and dolomite increased in the same sequence. The insoluble impurities are mainly silica, alumina, and ferric oxide, but the one that appears to be chiefly responsible for the above relation is silica, in the form of chert and sand.

Although some surface erosion has taken place and differences in the state of such erosion may be partly responsible for differences in depth to bedrock, the difference in average depth to bedrock cannot be explained entirely on that basis, except for soils underlain by shale or sandstone. In the association of the Colbert, Talbott, Decatur, Dewey, Fullerton, Clarksville, and Bolton series, the depth to bedrock is more or less in direct opposition to what would be expected if differential natural erosion were responsible; that is, when the predominating slopes of the respective series are taken into consideration. Considering the high rainfall, the streams in the limestone sections are relatively scarce and many of them sink into underground channels. Sinks everywhere dot the landscape and much drainage water escapes through them.

This condition indicates that the present relief is mainly due to differential dissolution and leaching of the underlying rocks; and, if this is true, the present covering over the rocks is the insoluble residue left after hundreds of feet of limestone and dolomite have been dissolved and leached out. The deepest coverings would, therefore, be expected where the limestone and dolomite had the highest concentrations of insoluble impurities, especially of chert and sand. As the covering became thicker and thicker, it served as an increasingly effective sponge in reducing the quantity of water leaching through the underlying rocks, hence the increase in altitude with increase in content of insoluble impurities. The Colbert and Talbott soils, therefore, are the shallowest to bedrock and, at the same time, normally occupy the lowest positions in the valley, and Clarksville, Bolton, and Fullerton are the deepest to bedrock and occupy the highest positions, with the Decatur and Dewey soils between these two extremes. A fact of importance, however, is that the rocks underlying the Colbert and Talbott soils contain some clayey material and such rocks have been observed generally to leave heavy slowly permeable residual material. The natural erosion of such material, therefore, may be generally greater, and this accounts in part for the shallow depth of soil material over such rocks.

As already pointed out, the Talbott soils are underlain by limestone containing some clay, but they are low in siliceous material. A description of a typical profile is as follows:

A_1. 0 to 1½ inches, grayish-brown friable mellow silt loam, slightly stained with organic matter.

A_2. 1½ to 7 inches, light grayish-brown to pale yellowish-brown silt loam to silty clay loam. The color is not uniform but consists of a mingling of gray, light brown, and pale yellow. The material readily falls apart into soft crumbs of various size and shape. The dark-colored aggregates are firmer than the light-colored ones. Roots are numerous.

B_2. 7 to 20 inches, yellowish-red to light brownish-red tight tough

plastic and sticky silty clay, containing some minglings of olive, ocherous yellow, and red. The material is difficult to disrupt and breaks into firm, angular or blocky aggregates that range from ½ to 1½ inches in diameter. The predominant size of the aggregates increases somewhat in going from the upper to the lower part of this layer. Most of these are red or brownish-red on the outside and yellow or olive on the inside and they have shiny glossy surfaces. Fine roots are relatively scarce, and they generally occur between the aggregates, indicating that they do not readily penetrate them; but large roots are fairly numerous.

C_1. 20 to 24 inches, heavy silty clay similar to the layer above but more highly splotched and mottled with olive, yellow, red, and brown. It is also not quite so tough. Although broken with difficulty, the disrupted pieces break readily into angular aggregates with glossy surfaces.

C. 24 inches to bedrock, very plastic clay or silty clay, highly mottled and splotched with red, reddish brown, rust brown, yellow, gray, and olive. It contains a few small fragments of chert and limestone that continue down to bedrock, which is at a depth of 3 to 5 feet.

As the rock floor is uneven and jagged, the depth to bedrock is variable, but it is generally only a few feet. Rock outcrops are a common occurrence on nearly all areas of Talbott soils, and most stony land in the valley has Talbottlike soils between the outcrops where the depth to bedrock is deep enough to allow a soil to develop. As a result of this variable depth to bedrock, the layers between the A_2 horizon and bedrock differ greatly in depth and in many places are almost entirely absent.

Partly because of the heavy nature of the subsoil of the Talbott soils, they are highly susceptible to erosion even on mild slopes, and, after being cleared of the forest cover, much of the soil has been so eroded that in many areas the present profile is truncated and practically devoid of an A horizon.

As has been pointed out, the Talbott soils are underlain by limestone that is low in insoluble impurities, especially silica, and consequently the residual material from dissolution and leaching is relatively little. Apparently the quality of the residuum is responsible for the development of the Talbott soils.

Most of the Talbott soils are gently rolling, but some are hilly. It is not improbable that some of these on the steeper slopes are from rocks that on milder slopes would give rise to Dewey soils, but which have not developed because of rapid natural erosion.

As has been pointed out previously, the Decatur soils come from high-grade limestone that is a little higher in insoluble impurities, especially silica, than that underlying the Talbott. Most of them are developed on undulating and gently rolling upland areas. Rock outcrops are rare. They have the darkest A horizon of any well-developed soil in the valley, which indicates a higher content of organic matter. Because these are among the most fertile of all the well-developed soils in the valley, it is assumed that they supported the most luxuriant vege-

tation, and the natural result of this would be an A horizon dark in color. It is likely that the forest undergrowth was heavy and that this was instrumental in developing the granular structure of the A horizon. This luxuriant growth would also tend to inhibit erosion of the surface and develop a friable consistence of both the surface and subsoil.

The Decatur are among the darkest red soils in the valley, and they also have deep solums. They probably have the best combination of soil characteristics for plant growth of the soils of the uplands. A description of a typical uneroded profile of Decatur is as follows:

A_1. 0 to 2 inches, dark-brown smooth mellow and friable silt loam, which falls readily into soft granules, and contains many small roots, some insects, and a little leafmold.

A_2. 2 to 12 inches, dark reddish-brown soft smooth friable silt loam, which crumbles readily into soft granules, easily crushed.

B_1. 12 to 30 inches, brownish-red moderately friable silty clay loam, which crumbles fairly easily into soft angular particles, easily crushed to a smooth uniform slightly plastic mass, a little lighter colored than the uncrushed aggregates. Some of the aggregates are dark brown. Numerous tiny black concretions and a few small chert fragments are generally present. On exposed cuts, this layer is dark red.

B_2. 30 to 50 inches, a maroon-red silty clay, which is moderately firm and tight in place, but displaced pieces break readily into subangular aggregates ¼ to ½ inch in diameter. Many of these are coated with material containing numerous tiny black concretions and in some places small chert fragments. With moderate pressure the aggregates break down to a lighter colored fairly smooth moderately plastic and moderately sticky mass. The aggregates have a shiny surface. A few faint yellow splotches appear in the lower part.

B_3. 50 to 80 inches, a layer that is similar to the B_2 but does not have so many black coatings on the aggregates, contains fewer concretions, and is a little tighter, firmer, and a more brilliant maroon red. A few yellow splotches and shale fragments appear here and there.

C. 80 to 100 inches, a red (considerably lighter than above) heavy plastic sticky tight clay, containing a few yellow and olive mottlings and a few small shale fragments.

The Dewey soils are developed from limestone, apparently higher in insoluble impurities, particularly silica, than the rocks underlying the Decatur soils. Following is a profile description of Dewey silt loam:

A_1. 0 to 1½ inches, dark-brown soft mellow silt loam that falls readily into soft granules. It is high in organic matter.

A_2. 1½ to 12 inches, light-brown friable mellow soft silt loam, with a good distribution of roots.

B_1. 12 to 18 inches, light reddish-brown friable heavy silty clay loam, which breaks into small soft granules that are easily crushed to a smooth mass. The material is moderately sticky when wet.

B_2. 18 to 40 inches, brownish-red to bright-red fairly firm but friable silty clay, which breaks into irregular-sized subangular aggregates that are fairly easily crushed to a smooth light-red mass. The aggregates are generally glossy on the surface. The material is only slightly plastic when wet and contains numerous small black round concretions.

B_3. 40 to 60 inches, light-red fairly stiff and tight silty clay containing an occasional splotch of yellow. It is rather difficult to disrupt but displaced material breaks readily into angular and subangular aggregates of various sizes, which, with moderate pressure, can be crushed to a smooth yellowish-red moderately plastic and sticky mass.

C. 60 to 72 inches, heavy stiff plastic sticky clay. It is chiefly red but is highly mottled with yellow, olive, and gray. When displaced it breaks into more or less angular aggregates.

The predominating relief of the Dewey soils is rolling, but extensive areas occur on undulating relief. As this soil is productive of crops, it probably supported a luxuriant vegetation before it was cleared, and this at least partly accounts for the brown color of the A horizon. The forest undergrowth was probably heavy.

The Fullerton soils are derived from dolomitic limestone and dolomite relatively high in impurities, particularly silica. The silica occurs in two forms—as chert, and as fine-grained sand in the dolomite. The relief on which most of the Fullerton soils are found is typically rolling, hilly, or steep. These soils, particularly the cherty silt loam, are not so susceptible to erosion as the Dewey, Decatur, and Talbott soils on corresponding slopes. A profile description of typical Fullerton silt loam is as follows:

A_1. 0 to 2 inches, dark-gray silt loam stained dark by organic matter. Roots are numerous and chert fragments are moderately plentiful.

A_2. 2 to 9 inches, brownish-gray soft mellow and friable silt loam containing a few chert fragments.

A_3. 9 to 14 inches, pale-yellow heavy silt loam, which is very friable and contains a few chert fragments.

B_2. 14 to 40 inches, yellowish-red or red silty clay loam with a few minglings of yellow. It is firm in place, but displaced pieces are friable and break easily into irregular-sized and-shaped aggregates that with moderate pressure crush to a slightly gritty mass. When wet, it is moderately sticky and plastic. This layer generally contains numerous chert fragments, some of which are large.

C_1. 40 to 70 inches, tight plastic and sticky clay, which is reddish yellow mottled with some ocher yellow, olive, gray, and red. The material has a more angular structure than that in the layer above.

C. 70 to 84 inches, a tight tough plastic and sticky clay, which is reddish yellow highly mottled with yellow, gray, olive, and red that continues to a depth of more than 84 inches.

Fullerton cherty silt loam differs from Fullerton silt loam in containing considerably more chert fragments, but the color throughout the entire profile will generally be somewhat lighter. This is especially true of the A_2 and A_3 horizons. In many places these layers are also somewhat thicker, and the B horizon is more variable in thickness. This soil has apparently developed from weathered materials of dolomite containing more chert than those underlying the silt loam.

Fullerton fine sandy loam differs from the silt loam in being coarser textured, which is owing to the presence of sand and sandstone layers in the dolomite from which the parent material has weathered. In general the profiles of the two types are similar, although the A horizon of the sandy type is looser. Fullerton cherty fine sandy loam differs from Fullerton fine sandy loam in containing considerably more chert and blocky sandstone fragments.

The Clarksville soils are associated with the Fullerton soils. They come from dolomite higher in impurities, particularly chert, than the Fullerton. Like the Fullerton, they generally occupy rolling, hilly, and steep areas on the ridges, but differ from them primarily in being lighter colored in both the A and B horizons. The Clarksville soils contain splotches of red in the lower B and C horizons. Following is a profile description of Clarksville cherty silt loam:

A_1. 0 to 1½ inches, gray friable cherty silt loam stained dark with organic matter.

A_2. 1½ to 10 inches, pale yellowish-gray friable silt loam that contains considerable gritty material and chert fragments.

B_2. 10 to 20 inches, yellow to pale brownish-yellow silty clay loam, which is friable and breaks readily into successively smaller particles until a gritty mass is formed. It contains numerous chert fragments and a few tiny black concretions.

B_3. 20 to 26 inches, gradational layer of fairly friable silty clay loam. The color is a mingling of yellow, brownish yellow, brownish red, and light red. The material crushes to a light reddish-yellow gritty mass, which is friable and also slightly brittle. It breaks readily into angular and subangular firm granules, some of which are red on the outside and yellow on the inside.

C_1. 26 to 50 inches, a silty clay loam, the color of which is a mingling of light red, yellow, brownish yellow, gray, and olive. The material is rather hard in place, but disrupted pieces are brittle although moderately friable. It breaks readily into angular aggregates ⅛ to ¼ inch in diameter that crush to a fairly smooth yellowish-red mass.

C. 50 to 70 inches, a rather stiff tight sticky and plastic clay. The main color is light reddish yellow, but there are numerous mottlings of red, yellow, olive, and gray. This layer contains a considerable number of rather large chert fragments.

Where the differences in soils are as great as they are among the Fullerton and Clarksville and the Bolton soils, one would ordinarily expect differences in the parent material and hence in the underlying

rocks from which the parent material has weathered. But in view of the fact that the sandy dolomite underlying both the Fullerton and the Bolton soils appears to be quite uniform over relatively long belts, it is difficult to explain any difference between the parent material of these soils. Small fragments of hematite and ferruginous sandstone, however, have been observed in some places on the Bolton soils. The presence of these might indicate that the parent rocks under the Bolton soils are higher in iron than the parent rocks of the Fullerton and Clarksville soils, or it might indicate no appreciable difference in parent rock but critical differences in vegetation and leaching, even though such differences were not great.

The Bolton soils usually occur in association with the sandy members of the Fullerton and Clarksville series, but they are similar to the Dewey and Decatur soils in color. They differ from the Dewey and Decatur soils, however, in being more friable, lighter in texture, and more strongly sloping. In Grainger County the soils classified in the Bolton series are somewhat less friable in the subsoil than typical. A typical profile of Bolton loam has an A horizon, about 10 inches thick, consisting of brown mellow friable loam to silt loam. The B horizon extends to a depth of 50 to 70 inches and consists of a dark brownish-red to yellowish-brown firm but friable silty clay loam.

The Bolton soils usually occur on the east and north slopes, with the Fullerton and Clarksville soils on the south and west slopes. This is believed to be partly due to the fact that moisture relations are somewhat more favorable on the north and east slopes and this, in turn, aids biological activity, especially the growth of plants, and therefore retards leaching.

The soils of the Sequoia and Armuchee series are developed from interbedded shale and limestone. As compared with the soils developed over limestone, they are generally shallower to bedrock. These soils have developed from similar parent material. The Sequoia on undulating or rolling relief have fairly well developed profiles; the Armuchee on hilly or steep relief have only weakly developed profiles. Both of these soils have developed under a forest vegetation.

The A horizon of Sequoia silt loam (not mapped in the county) is a brownish-gray mellow silt loam, 6 to 8 inches thick. The B horizon is a reddish-yellow to brownish-yellow compact and tough silty clay, 12 to 15 inches thick. A few yellow and gray splotches are generally present in the lower part. The structure is blocky, and the aggregates range from ½ to 1½ inches in diameter. The C horizon is similar to the B except that it is highly splotched and mottled with yellow and gray and usually contains a considerable number of partly decomposed shale fragments. This layer extends to bedrock that is generally encountered between a depth of 2 and 5 feet. In most places the limestone has been leached from the upper few feet of the parent rock and acid shale remains.

The Armuchee soils are prevailingly steep and hilly and lack consistent development of the A and B horizons. The color of the soil is predominantly brownish yellow or reddish yellow, and the texture is predominantly a silty clay loam but ranges from a silt loam to a silty clay. Shale fragments are usually present throughout the profile. In a number of places weakly developed profiles somewhat resembling those

of the Sequoia have developed. Outcrops of limestone occur in a few places, but generally the carbonates have been leached from the upper foot or two of the parent rock, and acid shale therefore predominates. This soil varies considerably from place to place, depending largely on whether it is underlain by a lens of shale or a lens of limestone.

The soils of the Montevallo, Muskingum, Lehew, and Hector series are developed from weathered products of shale, interbedded shale and sandstone, or sandstone. These soils are shallow over bedrock and have only weakly developed profiles. The Montevallo soils occupy a wide range of relief (undulating to hilly). Where this soil occurs on a mild relief a profile has developed, but in this county most of these areas have been cleared and so badly eroded that they are now essentially azonal soils. The Muskingum, Lehew, and Hector soils are stony, have a hilly and steep relief, and are generally considered to be azonal-Lithosols. The Muskingum soils have grayish-yellow or yellowish-gray surface soils and brownish-yellow or yellow subsoils. The Lehew soils have purplish-gray or brownish-gray surface soils and purplish-yellow or purplish-brown subsoils. The Hector has a brownish-gray surface soil and a red or yellowish-red subsoil. These soils have developed under a forest vegetation consisting largely of hardwoods. The steep relief has accelerated geologic erosion, and owing to the resistant character of the underlying rock to weathering, the parent material has not lain in place long enough for well-developed profiles to have formed.

Colluvial land refers to those accumulations at the foot of slopes where geologic as well as accelerated erosion have been active. In most places the material is actually a combination of colluvium and local alluvium, but in some places it consists entirely of local alluvium. Many of the areas are small alluvial fans or cones at the mouths of very short drains and others are bottoms of limestone sinks. The soils of these so-called colluvial lands in Grainger County are classified as Emory, Greendale, Abernathy, Ooltewah, Guthrie, Hayter, Leadvale, and Jefferson series. Although the soils of none of these series can be considered old or fully mature, several of them do show considerable development and manifest color profiles of zonal soils. The degree of profile development, however, ranges from practically none where the accumulations are very recent depositions to fairly good development where the accumulations have been in place for considerable time.

The Emory, Greendale, Abernathy, Ooltewah, and Guthrie soils have developed from material that has been washed from soils of the uplands underlain by limestone. The Emory, Greendale, and Abernathy soils have developed under conditions of good drainage, the Ooltewah under conditions of intermediate drainage, and the Guthrie under conditions of poor drainage.

The Emory soils are brown and mellow and lie on the foot-slope areas where the gradient is enough for good surface drainage. In most places they show a rather indistinct profile development. The surface layer is usually brown to reddish-brown mellow silt loam 12 to 20 inches thick. The subsoil is reddish-brown to yellowish-brown friable heavy silt loam to silty clay loam extending to a depth of 35 to 50 inches. In this county they are usually developed from material washed from the Decatur, Dewey, Bolton, Fullerton, and Talbott soils.

The Greendale soils are similar to the Emory in several respects.

They differ, however, in having developed from material washed chiefly from the Clarksville and Fullerton soils. Although the Greendale soils differ greatly in degree of profile development, fairly well-defined profiles have developed in many places. In such places, the A horizon is about 9 inches thick and consists of a light grayish-brown mellow and friable silt loam. The B horizon is 12 to 18 inches thick and consists of a brownish-yellow friable heavy silt loam to silty clay loam. The C horizon is generally highly splotched with gray, yellow, red, and brown, but is similar to the B horizon in texture and consistence. Fragments of chert are present throughout the soil material in some places. This soil is generally medium to very strongly acid in reaction.

The Abernathy, Ooltewah, and Guthrie soils have developed in depressional areas which have little or no external drainage. These three soils differ from one another chiefly in the degree of internal drainage. The Abernathy has good internal drainage, the Ooltewah intermediate internal drainage, and the Guthrie poor internal drainage.

The Abernathy soil consists of material washed largely from the Decatur, Dewey, Bolton, Fullerton, and Talbott soils of the uplands. It shows very little profile development. In most places the material is brown to dark-brown mellow silt loam to a depth of 3 to 5 feet. In some places at depths of 2 feet or more below the surface a dark-colored layer is encountered which was probably the original surface soil before the surrounding upland was cleared.

The Ooltewah soil differs from the Abernathy chiefly in having inferior internal drainage and therefore in having a light-colored and mottled subsoil. As the parent material is generally young, the profiles of these soils are also young and undeveloped. As mapped this soil consists of a grayish-brown to brown mellow and friable silt loam to a depth of 10 to 20 inches. Below this the material becomes highly mottled with gray, yellow, and brown, and it generally becomes finer textured with increased depth.

The material of the Guthrie soil is usually washed from the Clarksville, Fullerton, and Talbott soils. It differs from the Abernathy and Ooltewah soils in being very poorly drained In most places the surface is light-gray friable silt loam, about 8 inches thick, underlain in most places by a gray silt loam highly mottled with rust brown and yellow. Usually at a depth of about 20 inches this grades into a fairly tough and compact silty clay, highly mottled with gray, yellow, and brown.

The Hayter soils have developed from material washed from soils underlain by sandstone. Material washed from shale and limestone, however, has contributed to the parent material of these soils and has had a strong influence on them. These soils have developed on a wide range of relief (undulating to steep). Where they have developed on a hilly and steep relief, geologic erosion has probably been the chief agency in the accumulation of parent material. In these places sandstone fragments ranging from a few inches to several feet in diameter are rather common. The Hayter soils vary considerably in their degree of profile development depending largely upon the length of time the soil material has lain in place. Usually, however, they have weakly developed profiles. In most places the 8- to 16-inch surface soil is brown mellow loam. The subsoil is usually reddish-brown or yellowish-brown friable clay loam 20 to 30 inches thick. The C horizon is usually similar

to the subsoil in texture and consistence but is splotched with yellow, red, brown, and gray.

The Leadvale soils have developed from material washed from the Montevallo, Lehew, and Armuchee soils. Like the other soils developed from colluvial and local alluvial materials, the Leadvale vary considerably in degree of profile development, but in many places fairly distinct A, B, and C horizons have formed. In such places the A horizon consists of brownish-gray friable silt loam, 8 to 10 inches thick and the B horizon of firm but friable yellow silty clay loam or heavy silt loam. The C horizon is firm and moderately compact silty clay loam mottled with gray, brown, and yellow. The Leadvale soils are normally medium to strongly acid in reaction.

The Jefferson soils have developed from material washed from the Muskingum soils. In most places they have fairly well developed profiles. The A horizon is usually about 10 inches thick and consists of a gray to brownish-gray friable fine sandy loam. The B horizon is ordinarily a yellow friable fine sandy clay about 20 inches thick. In most places the C horizon is a grayish-yellow friable fine sandy clay loam, splotched with brown and gray and containing a considerable number of sandstone fragments. A few sandstone fragments are usually present throughout the profile and in some places they are very numerous. The soils are normally strongly acid in reaction.

The mechanical analyses of samples of the surface, subsurface soil, and subsoil of Greendale loam and Cumberland silt loam are given in table 10.

TABLE 10.—*Mechanical analyses of Greendale loam and Cumberland silt loam*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Greendale loam:								
403559	0–8	1 0	2 7	9 1	19 5	3.4	45 6	18.7
403560	8–18	2 7	3 7	8.3	18.4	3 1	40 2	23.6
403561	18–30	1 4	2.8	9.0	17.7	3 8	36.4	28 9
403562	30–40	1 2	3.3	8.9	19 2	3 1	32.6	31.7
Cumberland silt loam:								
4035133	0–8	1.8	3 6	2.9	7 4	6 0	53.6	19.7
4035134	8–20	1 3	2.2	2 1	5 2	5 6	52 9	30.7
4035135	20–30	0 8	1.9	1.8	4 9	5 4	47.8	37.4
4035136	30–40	0 2	1.0	1.2	3.2	3 4	30 5	60 5

The soils of the stream terraces are classified into the Cumberland, Etowah, Waynesboro, Holston, Tyler, and Sequatchie series. Differences in the character of the alluvial material, drainage condition, and age account for most of the differences in these soils. The Cumberland and Etowah soils have developed from old alluvium originating from limestone, the Holston, Waynesboro, Tyler, and Sequatchie soils from old alluvium washed chiefly from land underlain by sandstone and shale. The Waynesboro, Holston, and Tyler constitute a catena in which the drainage is progressively poorer from the first to the last. The Sequatchie soil lies on the low terraces and has a young immature profile.

The Cumberland soils occupy the older, higher terrace positions. As previously stated the parent material is believed to have been washed largely from land underlain by limestone. The 10- to 15-inch A horizon is generally brown to reddish-brown mellow silt loam. The 30- to 50-inch B horizon is dark-red firm but friable silty clay loam. The C

horizon is generally a red to yellowish-red tough and plastic silty clay, splotched with yellow, red, gray, and brown. In a few places a layer or layers of quartzite gravel are present in this horizon. The relief normally ranges from gently sloping to sloping.

Like the Cumberland soils, the Etowah has also developed from materials washed largely from land underlain by limestone. These soils, however, have young and immaturely developed profiles. The 8- to 12-inch A horizon is brown mellow silt loam. In most places the B horizon is yellowish-brown heavy silt loam or silty clay loam, and the C horizon is normally grayish-brown silty clay loam, splotched with gray, yellow, and brown. The relief is gently sloping.

The Waynesboro soils have developed from material washed largely from land underlain by sandstone and shale. In most places the 7- to 10-inch A horizon is light-brown to brownish-gray friable fine sandv loam. The 20- to 30-inch B horizon is normally yellowish-red to red friable fine sandy clay loam. The underlying material is similar in texture and consistence but it is splotched with red, yellow, and gray. This material contains a few quartzite gravel in most places. The relief ranges from gently sloping to hilly.

The Holston soils have developed from a similar kind of old alluvium and on similar relief as Waynesboro. These soils, however, have a greater number of quartzite gravel throughout the profile and have been more highly leached. In most places the 8- to 12-inch A horizon is light-gray very fine sandy loam. The 15- to 25-inch B horizon is yellow firm but friable fine sandy clay. The underlying parent material is normally a moderately compact but friable sandy clay, splotched with red, yellow, gray, and brown. These soils are normally strongly to very strongly acid in reaction. In most places they are underlain by shale bedrock. The relief ranges from gently sloping to hilly.

The Tyler soil has developed on nearly level stream terraces where external drainage is slow. It is highly leached and, therefore, strongly acid to very strongly acid to considerable depths. It usually occurs on nearly level or depressional areas on the higher terraces in association with the Holston. The 8- to 16-inch surface layer is a light-gray floury very fine sandy loam. In most places the 10- to 20-inch subsoil is a somewhat tough and plastic grayish-yellow very fine sandy clay mottled with gray, yellow, and brown. The material underlying the subsoil is a fairly compact and impermeable silty clay which is dominantly gray in color but is mottled with bluish gray and yellow.

The Sequatchie soil has developed from old alluvium, most of which probably originated from soils underlain by sandstone and shale, but some of which apparently came from uplands underlain by limestone. The profile is slightly developed and surface and subsoil layers are normally present. In most places the 8- to 12-inch surface layer is a very friable light-brown to light grayish-brown fine sandy loam. The 15- to 25-inch subsoil is yellowish-brown to brownish-yellow friable fine sandy clay loam. The underlying material is normally similar in texture and consistence, but is brownish gray and in some places is lightly splotched with gray, brown, and yellow. This soil is normally medium to strongly acid in reaction. In most places the relief is mild.

The soils of the stream bottoms or flood plains are classified into the Huntington, Lindside, Melvin, Roane, Bruno, Pope, Philo, and Atkins

series. All these soils are young and show little or no consistent profile development. They are differentiated largely on the basis of differences in the parent material and drainage. All of them are occasionally flooded and thereby receive deposition of alluvial material.

The Huntington, Lindside, and Melvin soils have all developed from materials washed largely from land underlain by limestone. The Huntington soil is well drained, normally nearly neutral in reaction, and brown to depths of about 30 inches. The Lindside is imperfectly drained, normally about neutral in reaction, and is grayish-brown to depths of about 18 inches below which it is highly mottled with gray, brown, and yellow. The Melvin is poorly drained, about neutral in reaction, and is normally gray and mottled nearly to the surface.

The Roane soil consists largely of local alluvium from the Clarksville, Fullerton, and Bolton soils and occurs along small streams and intermittent drains. This soil is well drained, normally acid in reaction, and light brown to grayish brown to depths of 20 to 30 inches. In most places a layer of chert occurs at depths of about 30 inches or more and may be partly cemented in places.

The Bruno soils consist of alluvium washed from the uplands underlain by sandstone, shale, and limestone. They are normally nearly neutral in reaction. In most places they are light brown to depths of about 30 inches.

The Pope, Philo, and Atkins soils have all developed from materials washed largely from land underlain by sandstone and acid shale. They are all strongly acid in reaction, and differ from one another chiefly in drainage. The Pope soil is well drained and grayish brown to yellowish brown to a depth of about 30 inches, and the Philo is intermittently drained and grayish brown to depths of about 15 inches below which the material is highly mottled with gray, brown, and yellow. The Atkins soil is poorly drained and highly mottled with gray, brown, and yellow nearly to the surface. In drainage the Pope soil is comparable to the Huntington, the Philo to the Lindside, and the Atkins to the Melvin.

LITERATURE CITED

(1) ALLRED, C. E., WATKINS, S. W., and HATFIELD, G. H.
1929. TENNESSEE, ECONOMIC AND SOCIAL. PART II. . .THE COUNTIES. Tenn. Univ. Record 6 (3), 204 pp., illus.
(2) FENNEMAN, N. M.
1938. PHYSIOGRAPHY OF EASTERN UNITED STATES. 714 pp., illus. New York and London.
(3) FOSTER, A. P.
1923. COUNTIES OF TENNESSEE. Tenn. Dept. Ed., Hist. Div., 124 pp., Nashville, Tenn.
(4) GOODSPEED PUBLISHING COMPANY.
1887. HISTORY OF TENNESSEE FROM THE EARLIEST TIME TO THE PRESENT . . . [East Tenn. ed.], 1317 pp., illus. Chicago and Nashville.
(5) HALL, R. CLIFFORD.
1910. PRELIMINARY STUDY OF FOREST CONDITIONS IN TENNESSEE. Tenn. Geol. Survey, Bul. 10–A. 56 pp., illus.
(6) KILLEBREW, J. B., SAFFORD, J. M., CHARLTON, C. W., and BENTLEY, H. L.
1874. INTRODUCTION TO THE RESOURCES OF TENNESSEE. Tenn. Bur. Agr. Rpts. 1, 2, 1193 pp., illus.
(7) MOOERS, C. A.
1927. RATES AND DATES OF PLANTING FOR TENNESSEE FARM AND GARDEN CROPS. Tenn. Agr. Expt. Sta. Cir. 11, [8] pp., illus.
(8) RAMSEY, J. G. M.
1926. THE ANNALS OF TENNESSEE TO THE END OF THE EIGHTEENTH CENTURY . . Rev. ed., 832 pp. illus. Kingsport, Tenn.
(9) STERRETT, W. D.
1917. MARKETING WOODLOT PRODUCTS IN TENNESSEE. Tenn. Geol. Survey, Resources of Tenn. 7:109–195, illus.
(10) TENNESSEE VALLEY AUTHORITY, DEPARTMENT OF FORESTRY RELATIONS.
1941. AREA DATA FOR VALLEY COUNTIES. Forestry Data for the Tennessee Valley, Pt. 1. Forestry Bul. 3, 155 pp., illus.
(11) ———
1942. FOREST AREAS BY STATES AND COUNTIES AND TYPES OF OWNERSHIP. Forestry Data for the Tennessee Valley, Pt. III. Forestry Bul. 5, 25 pp., illus. Norris, Tenn.
(12) UNITED STATES DEPARTMENT OF AGRICULTURE.
1938. SOILS AND MEN. U. S. Dept. Agr. Yearbook 1938, 1232 pp., illus.
(13) UNITED STATES GEOLOGICAL SURVEY.
1896. GEOLOGIC ATLAS OF THE UNITED STATES, MORRISTOWN FOLIO, TENNESSEE. U. S. Geol. Survey, folio 27, [13] pp., illus.

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GRAINGER COUNTY, TENNESSEE, SOILS: SUMMARY OF IMPORTANT CHARACTERISTICS

Soil	Map symbol	Group (according to legend of soil map)	Topography	Internal drainage	Surface soil			Subsoil			Land classification
					Color	Consistence	Thickness	Color	Consistence	Texture	
			Percent Slope				Inches				
Abernathy silt loam	Ab	Well-drained soils of the first bottoms or depressions.	Nearly level; sinkholes	Free to medium	Brown or dark-brown mellow silt loam to about 30 inches below which the material is generally somewhat mottled.						1
Armuchee shaly silty clay loam: Severely eroded phase.	Aco	Soils of the hilly, steep, and very steep uplands; derived from interbedded limestone and shale.	Hilly	12–30	Slow	Most of the original surface soil washed away.		Reddish yellow	Moderately tough and plastic.	Shaly silty clay.	5
Severely eroded steep phase.	Acd	....do....	Steep	30–60	....do....	....do....	....do....	....do....	....do....	....do....	5
Armuchee silt loam	Am	....do....	Hilly	12–30	Medium to slow.	Dark gray to yellowish gray.	Friable	6	Reddish yellow to brownish yellow.	....do....	Silty clay	4
Steep phase	Ama	....do....	Steep	30–60	....do....	Grayish brown.	....do....	3–5	Yellowish red, mottled with gray.	Plastic	....do....	4
Very steep phase	Amv	....do....	Very steep	60–85	....do....	....do....	....do....	3–5	....do....	....do....	....do....	5
Armuchee silty clay loam: Eroded phase.	Asr	....do....	Hilly	12–30	....do....	Yellowish gray.	....do....	4–6	Reddish yellow to brownish yellow.	Moderately tough and plastic.	....do....	4
Eroded steep phase	Asf	....do....	Hilly to steep	30–50	....do....	Dark gray to yellowish gray.	....do....	6	....do....	....do....	....do....	4
Atkins fine sandy loam.	At	Poorly drained soils of the first bottoms, depressions, or terraces.	Nearly level.	.....	Very slow.	Gray mottled with yellow and brown.	....do....	7	Gray mottled with yellow and brown.	Firm but friable.	Fine sandy clay loam.	4
Bolton fine sandy loam	Bl	Soils of the undulating and rolling uplands; derived from cherty or siliceous limestone.	Hilly	12–30	Free	Brown to light reddish brown.	Very friable.	10	Brownish red or red.	Friable	Silty clay	3
Eroded phase	Blr	....do....	....do....	12–30	....do....	Reddish brown.	....do....	4–6	do.	Firm but permeable.	....do....	3
Eroded rolling phase.	Ble	....do....	Undulating to rolling	12	....do....	Brown to light reddish brown.	....do....	10	....do....	Friable	....do....	2
Eroded steep phase	Blf	Soils of the steep uplands; derived from cherty limestone.	Steep	25–40	....do....	....do....	....do....	10	....do....	....do....	....do....	4
Steep phase	Bls	....do....	Hilly to steep	25–40	....do....	....do....	....do....	10	....do....	....do....	....do....	4
Bolton silty clay loam: Severely eroded phase.	Bco	Soils of the undulating and rolling uplands; derived from cherty or siliceous limestone.	Hilly	12–30	Medium	Almost entirely lost by erosion.		0	....do....	....do....	....do....	4
Severely eroded steep phase.	Bcd	Soils of the steep uplands; derived from cherty limestone.	Hilly to steep.	25–45	....do....	....do....	....do....	0	....do....	Firm but permeable	....do....	5
Bruno fine sandy loam.	Bf	Well-drained soils of the first bottoms or depressions.	Nearly level to gently undulating.	.....	Free	Light brown or light yellowish brown.	Friable	15	Lighter brown than surface soil.	Friable	Fine loam or sandy clay loam.	2
Bruno loamy fine sand.	Bs	....do....	Undulating or gently billowy	.....	Very rapid.	....do....	....do....	20	Lighter colored than surface soil.	Loose	Fine sand	3
Clarksville cherty clay loam, severely eroded hilly phase.	Cfh	Soils of the hilly uplands; derived from cherty limestone	Hilly	12–30	Medium	Yellow	Moderately firm but friable.	Most surface soil lost by erosion.	Reddish yellow or yellowish red, splotched with red and gray.	Firm but friable.	Fine sandy clay with cherty.	5
Clarksville cherty fine sandy loam: Eroded phase.	Cfr	Soils of the undulating and rolling uplands; derived from cherty or siliceous limestone.	Undulating to rolling.	2–12	Free	Light gray.	Friable	6–14	Yellow	Moderately firm but friable.	Cherty fine sandy clay loam.	3
Eroded hilly phase.	Cfs	Soils of the hilly uplands; derived from cherty limestone.	Hilly	12–30	....do....	....do....	....do....	9–14	....do....	....do....	....do....	4
Hilly phase	Cfd	....do....	....do....	12–25	....do....	....do....	....do....	6–14	....do....	....do....	....do....	4
Clarksville cherty silt loam.	Cc	Soils of the undulating and rolling uplands; derived from cherty or siliceous limestone.	Undulating to rolling.	2–12	....do....	....do....	....do....	14	....do....	Firm but friable.	Cherty silty clay loam.	3
Eroded hilly phase	Ccf	Soils of the hilly uplands; derived from cherty limestone.	Hilly	12–30	....do....	Grayish yellow.	....do....	4–6	....do....	....do....	....do....	4
Eroded steep phase	Ccf	Soils of the steep uplands; derived from cherty limestone.	Steep	30–50	....do....	Light gray.	....do....	0–10	....do....	....do....	....do....	5
Hilly phase	Ccd	Soils of the hilly uplands; derived from cherty limestone.	Hilly	12–30	....do....	....do....	....do....	8–10	....do....	....do....	....do....	4
Steep phase	Ccs	Soils of the steep uplands; derived from cherty limestone.	Steep	30–50	....do....	....do....	....do....	12	....do....	....do....	....do....	5
Clarksville fine sandy loam: Eroded phase	Cfr	Soils of the undulating and rolling uplands; derived from cherty or siliceous limestone	Undulating to rolling.	2–12	....do....	....do....	....do....	6–14	....do....	Moderately firm but friable.	Fine sandy clay loam.	3
Eroded hilly phase	Cfh	Soils of the hilly uplands; derived from cherty limestone.	Hilly	12–30	....do....	....do....	....do....	6–14	....do....	....do....	....do....	4
Colbert silt loam.	Cb	Soils of the undulating and rolling uplands; derived from highly argillaceous limestone	Smooth undulating.	2–5	Slow	Brownish gray or yellowish gray.	....do....	6	Yellow mottled with gray and a little red and brown.	Tough plastic.	Silty clay.	3
Colbert silty clay loam, eroded rolling phase.	Cte	....do....	Rolling	5–12	....do....	....do....	....do....	6	....do....	....do....	....do....	4
Cumberland silt loam.	Cs	Undulating to sloping soils of the terraces.	Smooth to undulating.	2–5	Free	Dark brown.	Very mellow, friable.	14	Dark red.	Dense but permeable.	....do....	1
Cumberland silty clay loam, eroded sloping phase.	Cmk	....do....	....do....	2–5	Medium	Reddish brown.	Moderately friable.	5	....do....	....do....	....do....	2
Decatur silty clay loam: Eroded phase.	Dcr	Soils of the undulating and rolling uplands; derived from relatively pure limestone.	Rolling	5–12	....do....	....do....	....do....	5	Dark red or maroon red.	Firm, dense, but permeable.	....do....	2
Eroded hilly phase	Dcr	Soils of the hilly uplands; derived from relatively pure limestone.	Hilly	12–25	....do....	....do....	....do....	7	....do....	....do....	....do....	3
Eroded undulating phase.	Dcu	Soils of the undulating and rolling uplands; derived from relatively pure limestone.	Smooth to undulating.	2–5	....do....	Dark brown.	Very mellow, friable.	6–14	....do....	....do....	....do....	1
Severely eroded phase.	Dco	....do....	Rolling	5–12	....do....	Brownish red or dark red.	Dense.	Most of surface soil lost by erosion.	....do....	....do....	....do....	3
Severely eroded hilly phase.	Dch	Soils of the hilly uplands; derived from relatively pure limestone.	Hilly	12–30	....do....	....do....	....do....	....do....	....do....	....do....	....do....	4
Dewey silty clay loam: Eroded phase.	Dwr	Soils of the undulating and rolling uplands; derived from relatively pure limestone.	Rolling	5–12	....do....	Brown to light brown.	Very mellow, friable.	7–12	Light red to brownish red.	Firm but moderately friable.	....do....	2
Eroded undulating phase.	Dwu	....do....	Undulating	2–5	Free	Brown	....do....	8–12	....do....	....do....	....do....	1
Emory silt loam	Es	Soils of the relatively gently sloping colluvial slopes.	Gently sloping	2–5	....do....	....do....	Mellow	14	Reddish brown or yellowish brown.	Firm but friable	Silty clay loam.	1
Sloping phase	Esx	....do....	Rolling to hilly.	5–15	....do....	....do....	....do....	14	....do....	....do....	....do....	1
Etowah silt loam.	Et	Undulating to sloping soils of the terraces.	Gently undulating.	2–5	....do....	....do....	....do....	0–10	Yellowish brown.	Firm but permeable.	Silty clay loam to silty clay.	1
Fullerton cherty clay loam: Severely eroded phase.	Fro	Soils of the undulating and rolling uplands; derived from cherty or siliceous limestone.	Sloping or rolling.	5–12	....do....	Yellowish red.	Firm.....	Most of surface soil removed by erosion.	Yellowish red or light red.	Firm but friable and moderately compact.	Cherty fine sandy clay.	4
Severely eroded hilly phase.	Frh	Soils of the hilly uplands; derived from cherty limestone.	Hilly	12–30	....do....	....do....	Friable but firm.	....do....	....do....	....do....	....do....	5
Fullerton cherty fine sandy loam.	Fr	Soils of the undulating and rolling uplands; derived from cherty or siliceous limestone.	Rolling	5–12	....do....	Brownish gray to gray.	Friable	14	....do....	....do....	....do....	3
Eroded phase	Frr	....do....	....do....	5–12	....do....	Brownish gray or grayish yellow.	....do....	5	....do....	....do....	....do....	3
Eroded hilly phase	Frt	Soils of the hilly uplands; derived from cherty limestone.	Hilly	12–30	....do....	....do....	....do....	0–12	....do....	....do....	....do....	4
Hilly phase	Frl	....do....	....do....	12–30	....do....	Brownish gray to gray.	....do....	12	....do....	....do....	....do....	4
Fullerton cherty silt loam.	Fc	Soils of the undulating and rolling uplands; derived from cherty or siliceous limestone.	Undulating to rolling.	2–12	....do....	Brownish gray.	....do....	12	....do....	Firm but permeable.	Cherty silty clay loam or cherty silty clay.	3
Eroded phase	Frr	....do....	Rolling	5–12	....do....	Brownish gray or grayish yellow.	....do....	4–7	....do....	Firm but moderately friable.	....do....	3
Eroded hilly phase.	Fct	Soils of the hilly uplands; derived from cherty limestone.	Hilly	12–30	Medium	....do....	....do....	6	....do....	....do....	....do....	4
Eroded steep phase	Frf	Soils of the steep uplands; derived from cherty limestone.	Steep	30–60	....do....	....do....	....do....	5	....do....	....do....	....do....	5
Hilly phase	Frl	Soils of the hilly uplands; derived from cherty limestone.	Hilly	12–25	....do....	Brownish gray.	....do....	10	....do....	Firm but permeable.	Cherty silty clay loam.	4
Steep phase	Frs	Soils of the steep uplands; derived from cherty limestone.	Steep	30–60	....do....	....do....	....do....	9–10	....do....	....do....	Cherty silty clay.	5
Fullerton cherty silty clay loam: Severely eroded hilly phase.	Fsh	Soils of the hilly uplands; derived from cherty limestone.	Hilly	12–30	....do....	Reddish yellow.	Firm, cloddy when tilled.	Most of surface soil washed away.	....do....	Firm but friable.	....do....	4
Severely eroded steep phase.	Fsd	Soils of the steep uplands; derived from cherty limestone.	Steep	30–60	Medium to slow.	....do....	....do....	Surface soil largely lost by erosion.	....do....	Firm but permeable.	....do....	5
Fullerton fine sandy loam.	Ff	Soils of the undulating and rolling uplands; derived from cherty or siliceous limestone.	Undulating to rolling.	2–12	Free	Brownish gray to gray.	Very friable.	10	....do....	Friable but firm and moderately compact when dry.	Fine sandy clay.	2
Eroded phase	Ffr	....do....	Rolling	5–12	....do....	Brownish gray or grayish yellow.	Friable	5	....do....	....do....	....do....	2
Eroded hilly phase	Fft	Soils of the hilly uplands; derived from cherty limestone.	Hilly	12–30	....do....	....do....	....do....	0–12	....do....	....do....	....do....	3
Hilly phase	Ffh	....do....	....do....	12–30	....do....	Brownish gray to gray.	....do....	12	....do....	....do....	....do....	3
Severely eroded hilly phase.	Ffh	....do....	....do....	12–30	....do....	Yellowish red.	Firm, moderately compact.	Surface soil largely lost by erosion.	....do....	....do....	....do....	4
Undulating phase.	Ffu	Soils of the undulating and rolling uplands; derived from cherty or siliceous limestone.	Undulating.	2–5	....do....	Brownish gray to gray.	Friable	14	....do....	....do....	....do....	2
Fullerton silt loam: Eroded phase.	Ffr	....do....	Undulating to rolling.	2–12	....do....	Brownish gray or grayish yellow.	....do....	5	....do....	Firm but permeable.	Silt loam to silty clay.	2
Eroded hilly phase.	Fst	Soils of the hilly uplands; derived from cherty limestone.	Hilly	12–25	....do....	....do....	Firm	5–10	....do....	Firm but friable.	....do....	3
Hilly phase	Fsl	....do....	....do....	12–25	....do....	Brownish gray.	....do....	10	....do....	Firm but permeable.	....do....	3
Greendale loam.	Gl	Soils of the relatively gently sloping colluvial slopes.	Gently sloping	2–5	Somewhat retarded.	Brownish gray to grayish brown.	Friable	10	Brownish yellow.	Firm but friable.	Silty clay loam.	2
Sloping phase	Glx	....do....	Sloping or rolling.	5–15	Somewhat retarded.	Brownish gray to gray.	Friable	4–12	Brownish yellow.	Firm but friable.	Silty clay loam.	2
Greendale silty clay loam.	Ge	....do....	Gently sloping	5	Slow	Grayish brown.	Mellow	8	Yellow	Plastic	Silty clay loam or silty clay.	2
Sloping phase	Gex	....do....	Sloping or rolling.	5–15	....do....	....do....	....do....	8	....do....	....do....	....do....	3
Guthrie silt loam	Gs	Poorly drained soils of the first bottoms, depressions, or terraces.	Nearly level or saucer-like.	.....	Very slow.	Gray	....do....	8	Gray mottled with yellow and brown.	Firm	Silty clay loam.	4
Hayter loam	Ht	Soils of the relatively gently sloping colluvial slopes.	Gently sloping	5	Free	Brown	....do....	5–15	Reddish brown or yellowish brown.	Friable	Clay loam	1
Eroded sloping phase.	Htk	....do....	Sloping or rolling.	5–15	....do....	....do....	....do....	6–8	....do....	....do....	....do....	2
Hayter stony loam: Eroded phase.	Hnr	....do....	Gently sloping to sloping.	2–12	....do....	....do....	....do....	8	....do....	....do....	....do....	3
Eroded hill phase.	Hnh	Soils of the steeper colluvial slopes.	Hilly	12–30	....do....	Brown or grayish brown.	....do....	5–10	....do....	....do....	....do....	4
Eroded steep phase.	Hnf	....do....	Steep	30–50	....do....	....do....	....do....	5	....do....	....do....	....do....	4
Hill phase	Hne	....do....	Hilly	12–30	....do....	....do....	....do....	10	....do....	....do....	....do....	4
Severely eroded steep phase.	Hnd	....do....	Steep	30–50	Free to medium	Yellowish brown to reddish brown.	Friable	Nearly all surface soil lost by erosion	Yellowish brown to reddish brown.	....do....	....do....	5
Steep phase	Hnx	....do....	....do....	30–50	Free.	Grayish brown to brown.	Mellow	8	....do....	....do....	....do....	4
Hector stony fine sandy loam.	Hf	Soils of the hilly and steep uplands; derived from interbedded sandstone and shale.	....do....	30–60	....do....	Grayish yellow.	Moderately loose.	10	Yellowish red to reddish yellow.	....do....	Fine sandy clay.	5
Hilly stony land: Colbert soil material	HsC	Stony, rough, or gullied land types.	Rolling to hilly.	5–30	Very slow.	Limestone and shale outcrops occupy more than 50 percent of area; limestone is clayey, purplish red; the soil material is yellow plastic clay, only 6 to 12 inches over bedrock.						4
Talbott soil material	HsT	....do....	Hilly, sinkholes.	12–30	....do....	Grayish-brown silty clay loam over yellowish-red or reddish-yellow plastic silty clay; limestone outcrops occupy as much as 50 percent of area; depth to bedrock rarely more than 36 inches.						4
Holston very fine sandy loam.	Hl	Undulating to sloping soils of the terraces.	Smooth	5	Free	Gray	Friable	10	Yellow	Firm but moderately friable.	Sandy clay.	2
Eroded sloping phase.	Hlk	....do....	Undulating to rolling.	5–12	....do....	Yellowish gray.	Moderately friable.	5	....do....	Firm but friable.	....do....	3
Huntington silt loam.	Hs	Well-drained soils of the first bottoms or depressions.	Level to gently undulating.	.....	....do....	Brown	Mellow	15	Light brown.	Firmer than surface.	Fine silt loam.	1
Jefferson stony fine sandy loam: Eroded phase.	Jsr	Soils of the relatively gently sloping colluvial slopes.	Gently sloping.	5	....do....	Brownish gray or yellowish gray.	....do....	6–10	Yellowish brown.	Firm but friable.	Sandy clay with sandstone fragments.	2
Eroded sloping phase.	Jsk	....do....	Rolling	5–15	....do....	....do....	....do....	5	....do....	....do....	....do....	3
Sloping phase	Jsx	....do....	....do....	5–15	....do....	Brownish gray.	....do....	9	....do....	....do....	....do....	3
Leadvale silt loam	Ls	....do....	Gently sloping.	5	Medium	....do....	....do....	8	Yellow or yellowish brown.	Firm	Silty clay loam.	2
Sloping phase	Lsx	....do....	Rolling	5–15	Free to medium	....do....	....do....	7	....do....	....do....	....do....	3
Lehew stony very fine sandy loam.	Lf	Soils of the hilly and steep uplands; derived from interbedded sandstone and shale.	Steep	30–60	Free	Purple or reddish gray.	....do....	10	Purplish brown or weak red.	Slightly firm but friable.	Fine sandy clay.	5
Eroded hilly phase.	Lfr	....do....	Hilly	12–30	....do....	Purplish gray or weak red.	Friable	4–10	Purplish yellow or weak red.	Firm but friable.	Sandy clay loam.	5
Limestone outcrop.	L	Stony, rough, or gullied land types.	Rolling to hilly.	.....	.....	Talbott soil material occupies less than 25 percent of area; rest of land consists of limestone outcrops and fragments.						5
Lindside silt loam.	Ll	Imperfectly drained soils of the first bottoms or depressions.	Nearly level.	.....	Slow.	Grayish brown or light yellowish brown.	Mellow	16	Mottled gray and light yellowish brown.	Firm	Silt loam.	2
Melvin silt loam	Ml	Poorly drained soils of the first bottoms, depressions, or terraces.	Level, depressions.	.....	Very slow.	Medium gray mottled with yellow and brown mottlings.	....do....	7	Medium gray mottled with yellow.	Moderately compact.	Silty clay loam or silty clay.	4
Montevallo shaly silt loam: Eroded hilly phase.	Mvt	Soils of the hilly and steep uplands; derived from acid shale.	Hilly	12–30	Medium	Brownish gray or pale brown.	....do....	4–8	Brownish yellow or very pale brown.	Moderately plastic.	Shaly silty clay.	5
Eroded rolling phase.	Mve	Soils of the undulating and rolling uplands; derived from acid shale.	Rolling	5–12	Free	Brownish yellow or pale brown.	....do....	4–8	Brownish yellow or pale brown.	....do....	....do....	4
Eroded undulating phase.	Mvu	....do....	Undulating.	5	....do....	....do....	....do....	5–8	....do....	....do....	....do....	4
Montevallo shaly silty clay loam: Severely eroded phase.	Mtc	Soils of the hilly and steep uplands; derived from acid shale.	Steep	30–60	....do....	Brownish yellow or very pale brown.	....do....	Surface soil largely lost by erosion.	....do....	....do....	....do....	5
Severely eroded rolling phase.	Mts	Soils of the undulating and rolling uplands derived from acid shale.	Undulating to rolling.	5–12	....do....	....do....	....do....	....do....	.....	....do....	....do....	5
Muskingum stony fine sandy loam.	Mf	Soils of the hilly and steep uplands; derived from interbedded sandstone and shale.	Steep	30–60	....do....	Yellowish gray.	Friable	10	Light yellowish brown to weak yellow.	Friable	Fine sandy clay loam or fine sandy clay.	5
Hilly phase	Mfl	....do....	Hilly	30	....do....	....do....	....do....	10	....do....	....do....	....do....	5
Muskingum very fine sandy loam	Mg	....do....	Steep	30–50	....do....	....do....	....do....	8	Yellow or light yellowish brown.	....do....	Very fine sandy clay loam.	5
Eroded phase	Mgr	....do....	....do....	30–50	do.	do.	do.	0–8	....do....	do.	Fine sandy clay loam; bedrock at 20 inches.	5
Eroded hilly phase.	Mgt	....do....	Hilly	12–30	....do....	....do....	....do....	0–8	....do....	....do....	Very fine sandy clay loam; bedrock at 20 inches.	5
Hilly phase	Mgl	....do....	....do....	12–30	....do....	....do....	....do....	8	....do....	....do....	Very fine sandy loam.	5
Oaktewah silt loam.	Os	Imperfectly drained soils of the first bottoms or depressions.	Nearly level or saucer-like.	.....	Slow	Grayish brown.	Mellow	16	Mottled gray, brown, and yellow.	....do....	Silt loam or silty clay loam.	2
Philo fine sandy loam.	Pf	....do....	Nearly level.	.....	....do....	Brownish gray.	.....	16	....do....	Firm but moderately friable.	Sandy clay loam or sandy clay.	3
Pope fine sandy loam.	Po	Well-drained soils of the first bottoms or depressions.	Nearly level or gently undulating.	.....	Free	Grayish brown or light yellowish brown.	Friable	8	Brownish yellow.	Friable	Fine sandy loam.	2
Roane silt loam.	Rs	....do....	Nearly level to gently sloping.	.....	Moderately free.	Light brown or moderate yellowish brown.	....do....	12	Moderate yellowish brown.	....do....	Silt loam; some chert in places.	2
Rolling stony land (Talbott soil material).	RlT	Stony, rough, or gullied land types.	Smooth to rolling.	15	Very slow.	Grayish-brown silty clay loam over yellowish-red tough plastic silty clay; limestone outcrops occupy up to 50 percent of area; depth of soil to bedrock seldom exceeds 36 inches.						4
Rough gullied land: Limestone residuum.	RgR	....do....	Sloping to steep	.....	.....	Occurs mostly in areas of badly eroded Fullerton, Clarksville, Bolton, Decatur, and Talbott soils.						5
Shale and sandstone residuum.	RgS	....do....	....do....	.....	.....	Much of it represents badly eroded Armuchee soils.						5
Rough stony land: Muskingum soil material.	RtM	....do....	Steep	30–60	.....	Consists of numerous sandstone outcrops and Muskingum stony fine sandy loam soil material.						5
Talbott soil material.	RsT	....do....	Steep	30–60	.....	Numerous limestone outcrops; soil material covers 25 to 75 percent of area and resembles Talbott and Colbert soils; some resembles Fullerton and Clarksville.						5
Sandstone outcrop.	S	....do....	Steep to precipitous.	.....	.....	Chiefly sandstone outcrops and fragments with thin accumulations of Muskingum stony fine sandy loam.						5
Sequatchie fine sandy loam.	Sc	Undulating to sloping soils of the terraces.	Gently undulating to undulating.	5	Free	Light brown or light yellowish brown.	Friable.	10	Yellowish brown.	Firm but friable.	Sandy clay loam or sandy clay.	2
Sequoia shaly silty clay loam, severely eroded phase.	Sco	Soils of the undulating and rolling uplands; derived from interbedded limestone and shale.	Rolling	5–12	Medium to slow.	Yellowish brown.	Moderately tough.	Surface soil largely lost by erosion.	Splotched or mottled yellowish red, yellow, and gray.	Moderately tough.	Silty clay	4
Sequoia silty clay loam: Eroded phase.	Ser	....do....	....do....	5–12	....do....	Light yellowish brown to moderate yellowish brown.	Friable	5–8	Light reddish yellow.	....do....	....do....	3
Eroded undulating phase.	Ssu	....do....	Undulating.	5	....do....	....do....	Moderately friable	5–8	....do....	....do....	....do....	2
Talbott silty clay loam: Eroded phase.	Ter	Soils of the undulating and rolling uplands; derived from relatively pure limestone.	Rolling	5–12	Rather slow.	Grayish brown.	Moderately friable when moist; hard when dry.	8	Yellowish red.	Sticky, plastic.	....do....	3
Eroded hilly phase.	Tet	Soils of the hilly uplands; derived from relatively pure limestone.	Hilly	12–30	Somewhat retarded.	....do....	....do....	6	....do....	....do....	....do....	4
Eroded undulating phase.	Teu	Soils of the undulating and rolling uplands; derived from relatively pure limestone.	Undulating.	5	Slow	....do....	Moderately friable.	10	....do....	Plastic	....do....	2
Severely eroded hilly phase.	Teh	Soils of the hilly uplands; derived from relatively pure limestone.	Hilly	12–30	....do....	Yellowish red.	Plastic when wet.	Most of original surface soil washed away.	....do....	Sticky, plastic.	....do....	5
Tyler very fine sandy loam.	Tv	Poorly drained soils of the first bottoms, depressions, or terraces.	Nearly level to slightly depressed.	0–5	....do....	Light gray.	Friable.	16	Grayish yellow mottled with yellow, gray, and brown.	Moderately compact.	Very fine sandy clay.	4
Waynesboro very fine sandy loam: Eroded phase.	Wvr	Undulating to sloping soils of the terraces.	Undulating.	5	Free	Light brownish gray to grayish brown.	....do....	8	Reddish yellow to yellowish red.	Friable	Sandy clay.	2
Eroded hill phase.	Wvh	Sloping and strongly sloping soils of the terraces.	Hilly	12–30	....do....	Brownish gray.	....do....	0–8	Reddish yellow.	....do....	....do....	4
Eroded sloping phase.	Wvk	Undulating to sloping soils of the terraces.	Rolling	5–12	....do....	....do....	....do....	4–6	....do....	....do....	....do....	2

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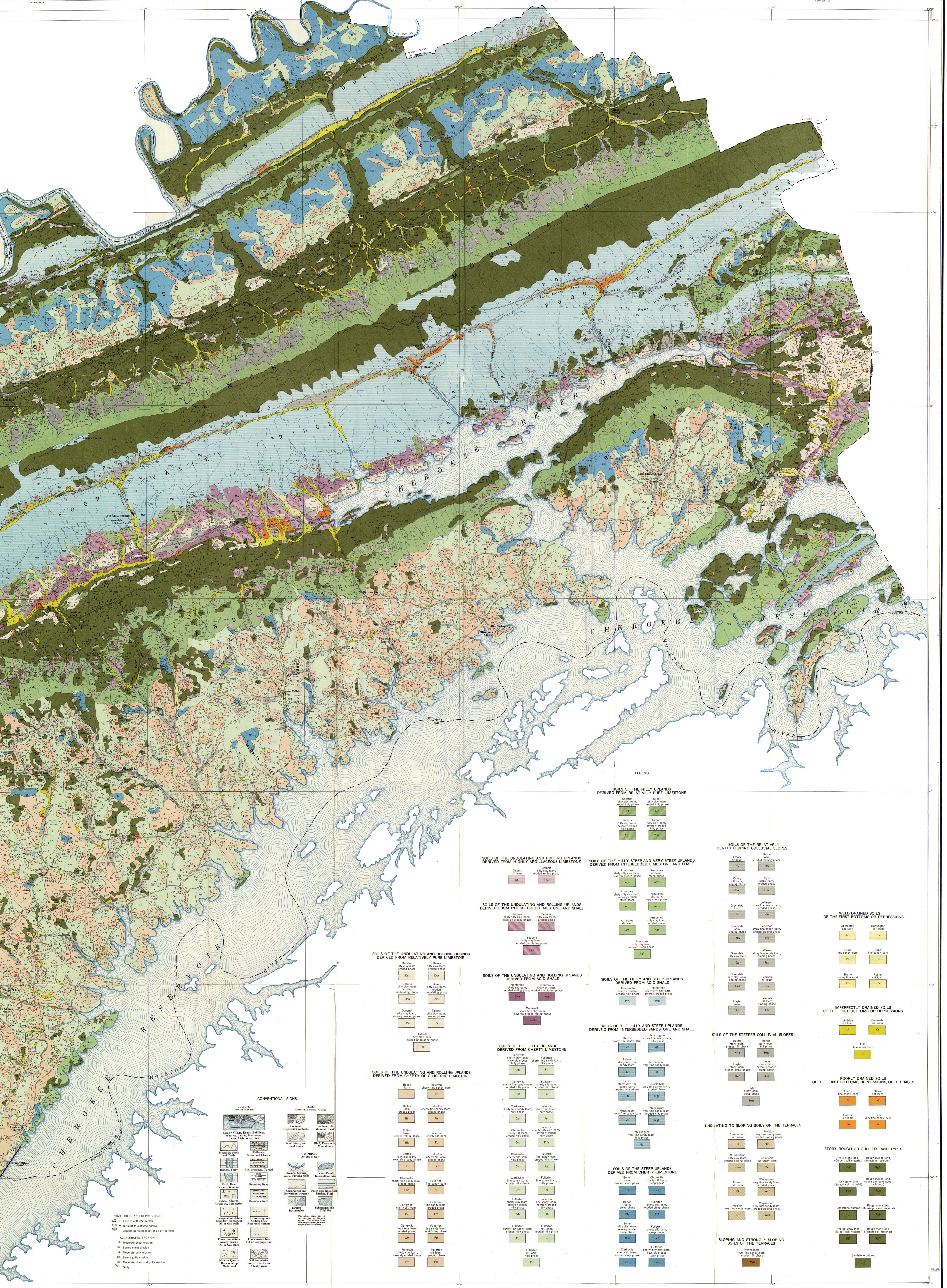


LEGEND

SOILS OF THE UNDULATING AND ROLLING UPLANDS DERIVED FROM HIGHLY ARGILLACEOUS LIMESTONE
- Colbert silt loam — Cb
- Colbert silty clay loam, eroded rolling phase — Cte

SOILS OF THE UNDULATING AND ROLLING UPLANDS DERIVED FROM INTERBEDDED LIMESTONE AND SHALE
- Sequoia shaly silty clay loam, severely eroded phase — Sco
- Sequoia silty clay loam, eroded phase — Ssr
- Sequoia silty clay loam, eroded undulating phase — Ssu

SOILS OF THE UNDULATING AND ROLLING UPLANDS DERIVED FROM RELATIVELY PURE LIMESTOIE
- Decatur silty clay loam, eroded phase — Dcr
- Dewey silty clay loam, eroded phase — Dwr
- Decatur silty clay loam, eroded undulating phase — Dcu
- Dewey silty clay loam, eroded undulating phase — Dwu
- Decatur silty clay loam, severely eroded phase — Dco
- Talbott silty clay loam, eroded phase — Tcr
- Talbott silty clay loam, eroded undulating phase — Tcu

SOILS OF THE UNDULATING AND ROLLING UPLANDS DERIVED FROM ACID SHALE
- Montevallo shaly silt loam, eroded rolling phase — Mve
- Montevallo shaly silt loam, eroded undulating phase — Mvu
- Montevallo shaly silty clay loam, severely eroded rolling phase — Mts

SOILS OF THE UNDULATING AND ROLLING UPLANDS DERIVED FROM CHERTY OR SILICEOUS LIMESTONE
- Bolton loam — Bl
- Fullerton cherty fine sandy loam — Ft
- Bolton loam, eroded phase — Blr
- Fullerton cherty fine sandy loam, eroded phase — Ftr
- Bolton loam, eroded rolling phase — Ble
- Fullerton cherty silt loam — Fc
- Bolton silty clay loam, severely eroded phase — Bco
- Fullerton cherty silt loam, eroded phase — Fcr
- Clarksville cherty fine sandy loam, eroded phase — Ckr
- Fullerton fine sandy loam — Ff
- Clarksville cherty silt loam — Cc
- Fullerton fine sandy loam, eroded phase — Ffr
- Clarksville fine sandy loam, eroded phase — Cfr
- Fullerton fine sandy loam, undulating phase — Ftn
- Fullerton cherty clay loam, severely eroded phase — Fro
- Fullerton silt loam, eroded phase — Fsr

SOILS OF THE HILLY UPLANDS DERIVED FROM RELATIVELY PURE LIMESTONE
- Decatur silty clay loam, eroded hilly phase — Dct
- Talbott silty clay loam, eroded hilly phase — Tct
- Decatur silty clay loam, severely eroded hilly phase — Dch
- Talbott silty clay loam, severely eroded hilly phase — Tch

SOILS OF THE HILLY, STEEP, AND VERY STEEP UPLANDS DERIVED FROM INTERBEDDED LIMESTONE AND SHALE
- Armuchee shaly silty clay loam, severely eroded phase — Aco
- Armuchee silt loam, steep phase — Amz
- Armuchee shaly silty clay loam, severely eroded steep phase — Acd
- Armuchee silt loam, very steep phase — Amv
- Armuchee silt loam — Am
- Armuchee silty clay loam, eroded phase — Asr
- Armuchee silty clay loam, eroded steep phase — Asf

SOILS OF THE HILLY AND STEEP UPLANDS DERIVED FROM ACID SHALE
- Montevallo shaly silt loam, eroded hilly phase — Mvt
- Montevallo shaly silty clay loam, severely eroded phase — Mto

SOILS OF THE HILLY AND STEEP UPLANDS DERIVED FROM INTERBEDDED SANDSTONE AND SHALE
- Hector stony fine sandy loam — Hf
- Muskingum stony fine sandy loam, hilly phase — Mfl
- Lehew stony very fine sandy loam — Lf
- Muskingum very fine sandy loam — Mg
- Lehew stony very fine sandy loam, eroded hilly phase — Lfr
- Muskingum very fine sandy loam, eroded phase — Mgr
- Muskingum stony fine sandy loam — Mf
- Muskingum very fine sandy loam, eroded hilly phase — Mgt
- Muskingum very fine sandy loam, hilly phase — Mgl

SOILS OF THE HILLY UPLANDS DERIVED FROM CHERTY LIMESTONE
- Clarksville cherty clay loam, severely eroded hilly phase — Clh
- Fullerton cherty fine sandy loam, hilly phase — Ftl
- Clarksville cherty fine sandy loam, eroded hilly phase — Ckt
- Fullerton cherty silt loam, eroded hilly phase — Fct
- Clarksville cherty fine sandy loam, hilly phase — Ckl
- Fullerton cherty silt loam, hilly phase — Fcl
- Clarksville cherty silt loam, eroded hilly phase — Cct
- Fullerton cherty silty clay loam, severely eroded hilly phase — Fnh
- Clarksville cherty silt loam, hilly phase — Ccl
- Fullerton fine sandy loam, eroded hilly phase — Fft
- Clarksville fine sandy loam, eroded hilly phase — Cft
- Fullerton fine sandy loam, hilly phase — Ffl
- Fullerton cherty clay loam, severely eroded hilly phase — Frh
- Fullerton fine sandy loam, severely eroded hilly phase — Ffh
- Fullerton cherty fine sandy loam, eroded hilly phase — Ftt
- Fullerton silt loam, eroded hilly phase — Fst
- Fullerton silt loam, hilly phase — Fsl

SOILS OF THE STEEP UPLANDS DERIVED FROM CHERTY LIMESTONE
- Bolton loam, eroded steep phase — Blf
- Clarksville cherty silt loam, steep phase — Ccz
- Bolton loam, steep phase — Blz
- Fullerton cherty silt loam, eroded steep phase — Fcf
- Bolton silty clay loam, severely eroded steep phase — Bcd
- Fullerton cherty silt loam, steep phase — Fcz
- Clarksville cherty silt loam, eroded steep phase — Ccf
- Fullerton cherty silty clay loam, severely eroded steep phase — Fnd

SOILS OF THE RELATIVELY GENTLY SLOPING COLLUVIAL SLOPES
- Emory silt loam — Es
- Hayter loam, eroded sloping phase — Htk
- Emory silt loam, sloping phase — Esx
- Hayter stony loam, eroded phase — Hnr
- Greendale loam — Gl
- Jefferson stony fine sandy loam, eroded phase — Jsr
- Greendale loam, sloping phase — Glx
- Jefferson stony fine sandy loam, eroded sloping phase — Jsk
- Greendale silty clay loam — Gc
- Jefferson stony fine sandy loam, sloping phase — Jsx
- Greendale silty clay loam, sloping phase — Gcx
- Leadvale silt loam — Ls
- Hayter loam — Ht
- Leadvale silt loam, sloping phase — Lsx

SOILS OF THE STEEPER COLLUVIAL SLOPES
- Hayter stony loam, eroded hill phase — Hnb
- Hayter stony loam, hill phase — Hnc
- Hayter stony loam, eroded steep phase — Hnf
- Hayter stony loam, severely eroded steep phase — Hnd
- Hayter stony loam, steep phase — Hnz

UNDULATING TO SLOPING SOILS OF THE TERRACES
- Cumberland silt loam — Cs
- Holston very fine sandy loam, eroded sloping phase — Hlk
- Cumberland silty clay loam, eroded sloping phase — Cmk
- Sequatchie fine sandy loam — Se
- Etowah silt loam — Et
- Waynesboro very fine sandy loam, eroded phase — Wvr
- Holston very fine sandy loam — Hl
- Waynesboro very fine sandy loam, eroded sloping phase — Wvk

SLOPING AND STRONGLY SLOPING SOILS OF THE TERRACES
- Waynesboro very fine sandy loam, eroded hill phase — Wvb

WELL-DRAINED SOILS OF THE FIRST BOTTOMS OR DEPRESSIONS
- Abernathy silt loam — Ab
- Huntington silt loam — Hs
- Bruno fine sandy loam — Bf
- Pope fine sandy loam — Po
- Bruno loamy fine sand — Bs
- Roane silt loam — Rs

IMPERFECTLY DRAINED SOILS OF THE FIRST BOTTOMS OR DEPRESSIONS
- Lindside silt loam — Ll
- Ooltewah silt loam — Os
- Philo fine sandy loam — Pf

POORLY DRAINED SOILS OF THE FIRST BOTTOMS, DEPRESSIONS, OR TERRACES
- Atkins fine sandy loam — Af
- Melvin silt loam — Ml
- Guthrie silt loam — Gs
- Tyler very fine sandy loam — Tv

STONY, ROUGH OR GULLIED LAND TYPES
- Hilly stony land (Colbert soil material) — HsC
- Rough gullied land (limestone residuum) — RgR
- Hilly stony land (Talbott soil material) — HsT
- Rough gullied land (shale and sandstone residuum) — RgS
- Limestone outcrop — L
- Rough stony land (Muskingum soil material) — RsM
- Rolling stony land (Talbott soil material) — RlT
- Rough stony land (Talbott soil material) — RsT
- Sandstone outcrop — S

CONVENTIONAL SIGNS

CULTURE (Printed in Black): City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort; Secondary roads and Trails; Railroads Steam and Electric; Bridges, Ferry; R.R. crossings, Tunnel; Ford, Dam, Sawmill, Windmill; Boundary lines; School, Church, Creamery, Cemeteries; Boundary lines; Triangulation station, Boundary monument, Oil or Gas wells; U.S. township and Section lines, Recovered corners; Forest fire station, Airway beacon, Oil or Gas tanks; Transmission line, Oil or Gas pipe line; Mine or Quarry, Rock outcrop, Made land; Soil boundaries, Stony, Gravelly and Cherty areas

RELIEF (Printed in brown or black): Contours, Depression contours; Prominent Hills, Mountain Peaks; Sand, Wash, and Sand dunes; Bluff, Escarpment, Mine dumps

DRAINAGE (Printed in blue): Streams, Springs, Wells, Flowing wells; Lakes, Ponds, Intermittent lakes; Unsurveyed and Intermittent streams; Water pipe lines, Canals, Ditches, Flumes; Swamp, Salt marshes; Submerged marsh, Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

SINK HOLES AND DEPRESSIONS
- Easy to cultivate across
- Difficult to cultivate across
- Containing water most or all of the time

ACCELERATED EROSION
- S Moderate sheet erosion
- SS Severe sheet erosion
- G Moderate gully erosion
- GG Severe gully erosion
- SG Moderate sheet and gully erosion
- Gully

Area inspected by J. W. Moon, Principal Soil Scientist.
Soils surveyed by E. H. Hubbard, in charge, B. L. Matzek, and Clifton Jenkins, Tennessee Agricultural Experiment Station.

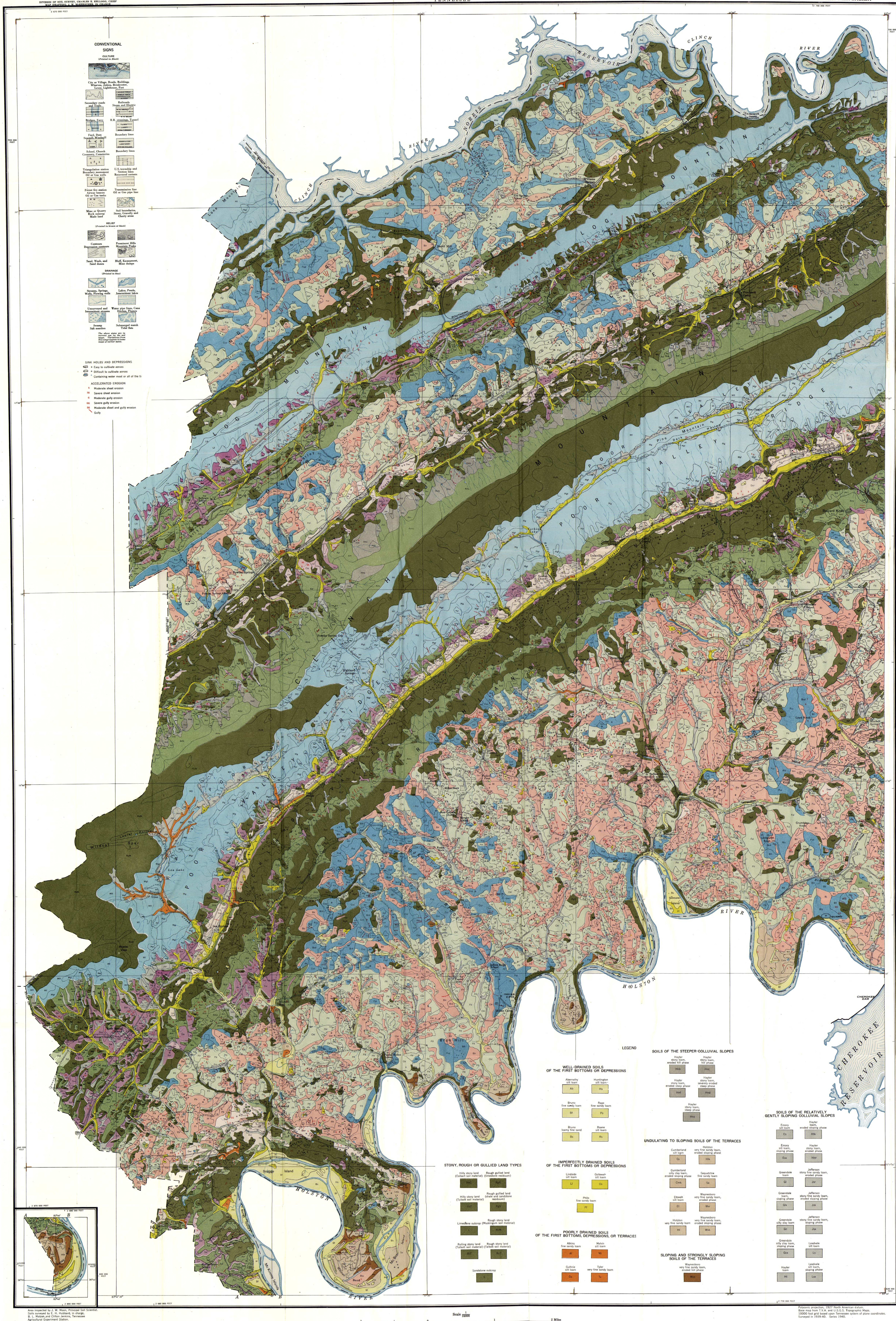
Scale 1/24000 — 1 Mile, 0, 1, 2 Miles; 5,000, 0, 5,000, 10,000 Feet

Polyconic projection, 1927 North American datum.
Base map from T.V.A. and U.S.G.S. Topographic Maps.
10000 foot grid based upon Tennessee system of plane coordinates.
Surveyed in 1939-40. Series 1940.

U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING
ROBERT M. SALTER, CHIEF
DIVISION OF SOIL SURVEY, CHARLES E. KELLOGG, CHIEF
MAP DRAFTING, J. W. McKERICHER, IN CHARGE

SOIL MAP
GRAINGER COUNTY–WESTERN SHEET
TENNESSEE

TENNESSEE AGRICULTURAL EXPERIMENT STATION
C. E. BREHM, DIRECTOR
F. S. CHANCE, VICE DIRECTOR
TENNESSEE VALLEY AUTHORITY


CONVENTIONAL SIGNS
CULTURE (Printed in Black)
City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort
Secondary roads and Trails
Railroads Steam and Electric
Bridges, Ferry
R.R. crossings, Tunnel
Ford, Dam Sawmill, Windmill
Boundary lines
School, Church Creamery, Cemeteries
Boundary lines
Triangulation station Boundary monument Oil or Gas wells
U.S. township and Section lines Recovered corners
Forest fire station Airway beacon Oil or Gas tanks
Transmission line Oil or Gas pipe line
Mine or Quarry Rock outcrop Made land
Soil boundaries, Stony, Gravelly and Cherty areas
RELIEF (Printed in brown or black)
Contours Depression contours
Prominent Hills Mountain Peaks
Sand, Wash, and Sand dunes
Bluff, Escarpment, Mine dumps
DRAINAGE (Printed in blue)
Streams, Springs, Wells, Flowing wells
Lakes, Ponds, Intermittent lakes
Unsurveyed and Intermittent streams
Water pipe lines, Canals, Ditches, Flumes
Swamp Salt marshes
Submerged marsh Tidal flats
The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.
SINK HOLES AND DEPRESSIONS
Easy to cultivate across
Difficult to cultivate across
Containing water most or all of the time
ACCELERATED EROSION
S Moderate sheet erosion
SS Severe sheet erosion
G Moderate gully erosion
GG Severe gully erosion
SG Moderate sheet and gully erosion
Gully
NORRIS
CLINCH RESERVOIR
CLINCH RIVER
HOLSTON RIVER
CHEROKEE RESERVOIR
CHEROKEE DAM
LEGEND
STONY, ROUGH OR GULLIED LAND TYPES
Hilly stony land (Colbert soil material) HsC
Rough gullied land (limestone residuum) RgR
Hilly stony land (Talbott soil material) HsT
Rough gullied land (shale and sandstone residuum) RgS
Limestone outcrop L
Rough stony land (Muskingum soil material) RsM
Rolling stony land (Talbott soil material) RlT
Rough stony land (Talbott soil material) RsT
Sandstone outcrop S
WELL-DRAINED SOILS OF THE FIRST BOTTOMS OR DEPRESSIONS
Abernathy silt loam Ab
Huntington silt loam Hs
Bruno fine sandy loam Bf
Pope fine sandy loam Po
Bruno loamy fine sand Bs
Roane silt loam Rs
IMPERFECTLY DRAINED SOILS OF THE FIRST BOTTOMS OR DEPRESSIONS
Lindside silt loam Ll
Ooltewah silt loam Os
Philo fine sandy loam Pf
POORLY DRAINED SOILS OF THE FIRST BOTTOMS, DEPRESSIONS, OR TERRACES
Atkins fine sandy loam Af
Melvin silt loam Ml
Guthrie silt loam Gs
Tyler very fine sandy loam Tv
SOILS OF THE STEEPER COLLUVIAL SLOPES
Hayter stony loam, eroded hill phase Hnb
Hayter stony loam, hill phase Hnc
Hayter stony loam, eroded steep phase Hnf
Hayter stony loam, severely eroded steep phase Hnd
Hayter stony loam, steep phase Hnz
UNDULATING TO SLOPING SOILS OF THE TERRACES
Cumberland silt loam Cs
Holston very fine sandy loam, eroded sloping phase Hlk
Cumberland silty clay loam, eroded sloping phase Cmk
Sequatchie fine sandy loam Se
Etowah silt loam Et
Waynesboro very fine sandy loam, eroded phase Wvr
Holston very fine sandy loam Hl
Waynesboro very fine sandy loam, eroded sloping phase Wvk
SLOPING AND STRONGLY SLOPING SOILS OF THE TERRACES
Waynesboro very fine sandy loam, eroded hill phase Wvb
SOILS OF THE RELATIVELY GENTLY SLOPING COLLUVIAL SLOPES
Emory silt loam Es
Hayter loam, eroded sloping phase Htk
Emory silt loam, sloping phase Esx
Hayter stony loam, eroded phase Hnr
Greendale loam Gl
Jefferson stony fine sandy loam, eroded phase Jsr
Greendale loam, sloping phase Glx
Jefferson stony fine sandy loam, eroded sloping phase Jsk
Greendale silty clay loam Gc
Jefferson stony fine sandy loam, sloping phase Jsx
Greendale silty clay loam, sloping phase Gcx
Leadvale silt loam Ls
Hayter loam Ht
Leadvale silt loam, sloping phase Lsx

LEGEND

SOILS OF THE UNDULATING AND ROLLING UPLANDS DERIVED FROM RELATIVELY PURE LIMESTONE

Decatur silty clay loam, eroded phase — Dcr
Dewey silty clay loam, eroded phase — Dwr
Decatur silty clay loam, eroded undulating phase — Dcu
Dewey silty clay loam, eroded undulating phase — Dwu
Decatur silty clay loam, severely eroded phase — Dco
Talbott silty clay loam, eroded phase — Tcr
Talbott silty clay loam, eroded undulating phase — Tcu

SOILS OF THE UNDULATING AND ROLLING UPLANDS DERIVED FROM CHERTY OR SILICEOUS LIMESTONE

Bolton loam — Bl
Fullerton cherty fine sandy loam — Ft
Bolton loam, eroded phase — Blr
Fullerton cherty fine sandy loam, eroded phase — Ftr
Bolton loam, eroded rolling phase — Ble
Fullerton cherty silt loam — Fc
Bolton silty clay loam, severely eroded phase — Bco
Fullerton cherty silt loam, eroded phase — Fcr
Clarksville cherty fine sandy loam, eroded phase — Ckr
Fullerton fine sandy loam — Ff
Clarksville cherty silt loam — Cc
Fullerton fine sandy loam, eroded phase — Ffr
Clarksville fine sandy loam, eroded phase — Cfr
Fullerton fine sandy loam, undulating phase — Ffn
Fullerton cherty clay loam, severely eroded phase — Fro
Fullerton silt loam, eroded phase — Fsr

SOILS OF THE UNDULATING AND ROLLING UPLANDS DERIVED FROM HIGHLY ARGILLACEOUS LIMESTONE

Colbert silt loam — Cb
Colbert silty clay loam, eroded rolling phase — Cte

SOILS OF THE UNDULATING AND ROLLING UPLANDS DERIVED FROM INTERBEDDED LIMESTONE AND SHALE

Sequoia shaly silty clay loam, severely eroded phase — Sco
Sequoia silty clay loam, eroded phase — Ssr
Sequoia silty clay loam, eroded undulating phase — Ssu

SOILS OF THE UNDULATING AND ROLLING UPLANDS DERIVED FROM ACID SHALE

Montevallo shaly silt loam, eroded rolling phase — Mve
Montevallo shaly silt loam, eroded undulating phase — Mvu
Montevallo shaly silty clay loam, severely eroded rolling phase — Mts

SOILS OF THE HILLY UPLANDS DERIVED FROM CHERTY LIMESTONE

Clarksville cherty clay loam, severely eroded hilly phase — Clh
Fullerton cherty fine sandy loam, hilly phase — Ftl
Clarksville cherty fine sandy loam, eroded hilly phase — Ckt
Fullerton cherty silt loam, eroded hilly phase — Fct
Clarksville cherty fine sandy loam, hilly phase — Ckl
Fullerton cherty silt loam, hilly phase — Fcl
Clarksville cherty silt loam, eroded hilly phase — Cct
Fullerton cherty silty clay loam, severely eroded hilly phase — Fnh
Clarksville cherty silt loam, hilly phase — Ccl
Fullerton fine sandy loam, eroded hilly phase — Fft
Clarksville fine sandy loam, eroded hilly phase — Cft
Fullerton fine sandy loam, hilly phase — Ffl
Fullerton cherty clay loam, severely eroded hilly phase — Frh
Fullerton fine sandy loam, severely eroded hilly phase — Ffh
Fullerton cherty fine sandy loam, eroded hilly phase — Ftt
Fullerton silt loam, eroded hilly phase — Fst
Fullerton silt loam, hilly phase — Fsl

SOILS OF THE HILLY UPLANDS DERIVED FROM RELATIVELY PURE LIMESTONE

Decatur silty clay loam, eroded hilly phase — Dct
Talbott silty clay loam, eroded hilly phase — Tct
Decatur silty clay loam, severely eroded hilly phase — Dch
Talbott silty clay loam, severely eroded hilly phase — Tch

SOILS OF THE HILLY, STEEP AND VERY STEEP UPLANDS DERIVED FROM INTERBEDDED LIMESTONE AND SHALE

Armuchee shaly silty clay loam, severely eroded phase — Aco
Armuchee silt loam, steep phase — Amz
Armuchee shaly silty clay loam, severely eroded steep phase — Acd
Armuchee silt loam, very steep phase — Amv
Armuchee silt loam — Am
Armuchee silty clay loam, eroded phase — Asr
Armuchee silty clay loam, eroded steep phase — Asf

SOILS OF THE HILLY AND STEEP UPLANDS DERIVED FROM ACID SHALE

Montevallo shaly silt loam, eroded hilly phase — Mvt
Montevallo shaly silty clay loam, severely eroded phase — Mto

SOILS OF THE HILLY AND STEEP UPLANDS DERIVED FROM INTERBEDDED SANDSTONE AND SHALE

Hector stony fine sandy loam — Hf
Muskingum stony fine sandy loam, hilly phase — Mfl
Lehew stony very fine sandy loam — Lf
Muskingum very fine sandy loam — Mg
Lehew stony very fine sandy loam, eroded hilly phase — Lfr
Muskingum very fine sandy loam, eroded phase — Mgr
Muskingum stony fine sandy loam — Mf
Muskingum very fine sandy loam, eroded hilly phase — Mgt
Muskingum very fine sandy loam, hilly phase — Mgl

SOILS OF THE STEEP UPLANDS DERIVED FROM CHERTY LIMESTONE

Bolton loam, eroded steep phase — Blf
Clarksville cherty silt loam, steep phase — Ccz
Bolton loam, steep phase — Blz
Fullerton cherty silt loam, eroded steep phase — Fcf
Bolton silty clay loam, severely eroded steep phase — Bcd
Fullerton cherty silt loam, steep phase — Fcz
Clarksville cherty silt loam, eroded steep phase — Ccf
Fullerton cherty silty clay loam, severely eroded steep phase — Fnd

Area inspected by J. W. Moon, Principal Soil Scientist.
Soils surveyed by E. H. Hubbard, in charge,
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Agricultural Experiment Station.

Scale 1/24000
1 ½ 0 1 2 Miles
5000 0 5000 10000 Feet

Polyconic projection, 1927 North American datum.
Base map from T.V.A. and U.S.G.S. Topographic Maps.
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